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# AIR SUPREMACY AND AIRLAND OPERATIONS

A thesis presented to the faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE



by

JOHN W. DAY, MAJ, USAF
B.S., United States Air Force Academy, 1977

Fort Leavenworth, Kansas
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Operation Desert Storm was one of the most successful military campaigns in United States history. Coalition air forces, led by the United States, waged an intense air campaign designed to weaken the Iraqi army prior to commencement of the ground war. According to Air Force doctrine, the first objective of this air campaign was to gain air supremacy over Iraqi airspace. Subsequently, air, ground, and naval forces were free to attack targets at the time and place of their choosing without effective interference from the Iraqi air force. This "umbrella" of air supremacy was invaluable during the ground campaign. Within the next ten years however, the United States Air Force may not possess the capability to project air supremacy over an adversary in a similar situation. Significant budgetary constraints could slow or stop new weapons research and procurement leaving the Air Force with fewer and older weapon systems to accomplish its mission. Increasing Soviet weapons proliferation could provide state-of-the-art weapons systems to any country capable of affording them. The net effect is that the Air Force could face a powerful enemy without the necessary equipment to accomplish its primary mission: Gain Control of the Aerospace Environment.

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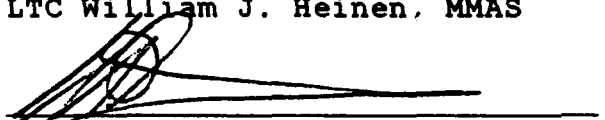
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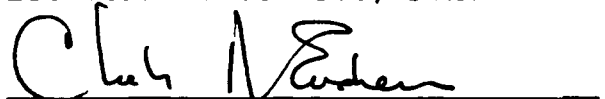
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## ABSTRACT

AIR SUPREMACY AND AIRLAND OPERATIONS by Major John W. Day, USAF, 119 pages.

Operation Desert Storm was one of the most successful military campaigns in United States history. Coalition air forces, led by the United States, waged an intense air campaign designed to weaken the Iraqi army prior to commencement of the ground war. According to Air Force doctrine, the first objective of this air campaign was to gain air supremacy over Iraqi airspace. Subsequently, air, ground, and naval forces were free to attack targets at the time and place of their choosing without effective interference from the Iraqi air force. This "umbrella" of air supremacy was invaluable during the ground campaign. Within the next ten years however, the United States Air Force may not possess the capability to project air supremacy over an adversary in a similar situation. Significant budgetary constraints could slow or stop new weapons research and procurement leaving the Air Force with fewer and older weapon systems to accomplish its mission. Increasing Soviet weapons proliferation could provide state-of-the-art weapons systems to any country capable of affording them. The net effect is that the Air Force could face a powerful enemy without the necessary equipment to accomplish its primary mission: **Gain Control of the Aerospace Environment.**

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# CHAPTER 1

# INTRODUCTION

## Background

Operation Desert Storm was one of the most successful military campaigns in United States history. The United States led a multinational coalition of land, sea, and air forces and destroyed the world's fourth largest military in less than two months. In the short period since the war, countless articles have been written praising the surgical use of air power to soften the Iraqi military and the effectiveness of our land forces which quickly forced the Iraqi land forces to capitulate.

During Operation Desert Storm, United States land forces fought in accordance with AirLand Battle, the current United States Army combat doctrine. AirLand Battle doctrine is in a state of evolution. The future for AirLand Battle is AirLand Operations. Both AirLand Battle and AirLand Operations stress the importance of joint air and land warfare. AirLand Operations are designed to conduct lethal operations throughout the more open, less structured battlefield of the future. Success will require a variety of air operations to include air force battlefield air

interdiction and air interdiction missions as well as army combat aviation and air assault missions. The success of these missions will ultimately depend on their ability to arrive at their targets without effective interference from an enemy's Integrated Air Defense System (IADS). In other words, their success will depend on our ability to provide air supremacy.

The AirLand Operations fought in Operation Desert Storm enjoyed the umbrella of air supremacy, the ultimate form of air superiority. This paper will highlight the important role of air supremacy during Operation Desert Storm and answer the primary question of this thesis:

## Thesis Question

**CAN WE ACHIEVE AIR SUPREMACY IN FUTURE AIRLAND OPERATIONS?**

There are a number of related issues that must be addressed and analyzed to answer this thesis question. What are the current and projected capabilities of the "Classical Soviet" IADS? What are the current and projected capabilities of U. S. air superiority assets? With respect to gaining and maintaining air superiority, was U.S. military doctrine applied during Operation Desert Storm? What are the trends regarding acquisition of future systems

designed to gain and maintain air superiority? Finally, can we project air supremacy over the ever enlarging AirLand Operations battlefield?

## Important Definitions

The following definitions will apply throughout this paper:

ADVANCED TACTICAL FIGHTER (ATF): The next generation air superiority fighter currently in development for the United States Air Force.

AIR INTERDICTION (AI): Aerospace operations designed to "delay, disrupt, divert, or destroy an enemy's military potential before it can be brought to bear effectively against friendly forces."[1]

AIRLAND BATTLE: "The U.S. Army's basic fighting doctrine... [which reflects] the structure of modern warfare, the dynamics of combat power, and the application of the classic principles of war."[2] AirLand Battle "takes an enlarged view of the battlefield, stressing unified air, ground, and sea operations throughout the theater."[3]

AIRLAND OPERATIONS: "The Army's umbrella concept for the evolution of AirLand Battle for the strategic Army of the 1990s and beyond."[4]

AIR SUPERIORITY: "That degree of dominance in the air battle of one force over another which permits the conduct

of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force."[5]

AIR SUPREMACY: "That degree of air superiority wherein the opposing air force is incapable of effective interference."[6]

ANTIAIRCRAFT ARTILLERY (AAA): Artillery whose primary purpose is the destruction of enemy aircraft. Soviet AAA ranges from small arms to 57mm and may be radar or optically guided.

BATTLEFIELD AIR INTERDICTION (BAI): "Air interdiction attacks against targets which are in a position to have a near-term effect on friendly land forces."[7]

COUNTER AIR OPERATIONS: Aerospace operations designed to gain control of the aerospace environment.[8]

DEFENSIVE COUNTER AIR (DCA): "Aerospace operations conducted to detect identify, intercept, and destroy enemy aerospace forces that are attempting to attack friendly forces or penetrate friendly airspace."[9]

INTEGRATED AIR DEFENSE SYSTEM (IADS): The combination of aircraft, surface-to-air missile systems, antiaircraft artillery systems, detection systems, and their associated Command and Control designed to intercept and destroy enemy air forces.

OFFENSIVE COUNTER AIR (OCA): "Aerospace operations conducted to seek out and neutralize or destroy enemy aerospace forces at a time and place of our choosing."[10]

SUPPRESSION OF ENEMY AIR DEFENSES (SEAD): "Aerospace operations which neutralize, destroy, or temporarily degrade enemy air defensive systems in a specific area by physical and/or electronic attack."[11]

SURFACE-TO-AIR MISSILE (SAM): A radar or infrared guided missile and its associated ground support equipment designed to intercept and destroy enemy aircraft.

## Constraints and Assumptions

AirLand Operations can be conducted across the entire spectrum of combat, from Low Intensity Conflict to Nuclear War. Therefore, I will assume that the enemy possesses a modern, Soviet-style IADS. A modern, Soviet-style IADS would provide a worst case scenario for the employment of United States aerospace forces. Comparison of United States weapon systems against an older, less capable IADS could result in an inflated portrayal of United States aerospace forces.

References to the Soviet Union, Soviets, or Consolidation of Independent States all refer to the same entity, the Union of Soviet Socialists Republics.

Discussion in this paper is limited to the United States capability to project air supremacy into enemy territory. I acknowledge a requirement to provide air supremacy over friendly airspace. Therefore, I will

consider the apportionment of forces to the defensive counter air mission and the subsequent impact this will have on the offensive counter air capabilities.

## CHAPTER 1 NOTES

[1]U.S. Air Force, AFM 1-1, Basic Aerospace Doctrine of the United States Air Force (Washington: Government Printing Office, 1984), 3-3.

[2]U.S. Army, FM 100-5, Operations (Washington: Department of the Army, 1986), 9.

[3]Ibid, 27.

[4]Training and Doctrine Command, PAM 525-5, AirLand Operations (Fort Monroe, Virginia: Department of the Army, 1991), 46.

[5]Joint Chiefs of Staff, PUB 1-02, Department of Defense Dictionary of Military and Associated Terms (Washington: Department of Defense, 1988), 26.

[6]Joint Chiefs of Staff, PUB 1-02, 27.

[7]AFM 1-1, 3-4.

[8]Ibid, 3-3.

[9]Ibid.

[10]Ibid.

[11]Ibid.

## CHAPTER 2

## METHODOLOGY

Can we achieve air supremacy in future AirLand Operations? The following topics must be discussed to answer this question. They are:

A. U.S. Air Force Doctrine

B. U.S. Army Doctrine

C. AirLand Operations

D. Operation Desert Storm

E. Soviet Integrated Air Defense System

F. Advanced Tactical Fighter

G. Future SEAD Aircraft

H. Composite Force Packages

Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force and Training and Doctrine Command Pamphlet (TRADOC) 525-5, AirLand Operations, establish the respective Air Force and Army combat doctrines. Together, they establish a requirement for air superiority and highlight its importance to the joint nature of modern war. Air operations during Operation Desert Storm provided an "air umbrella" for air, ground, and naval forces during the ground campaign by establishing air supremacy

over Iraqi airspace. Operation Desert Storm, therefore, is used to establish a baseline for the requirement of air superiority in future conflicts.

After establishing a requirement for this "air umbrella," this thesis analyzes U.S. Air Force and U.S. Army doctrine as it applied to air superiority and air supremacy. The focus of the research covers the following material:

1. Discuss the relationship of air superiority to air supremacy.

2. Discuss Air Force doctrine as it applies to AirLand Operations. Discussion should include air superiority, air supremacy, suppression of enemy air defenses, air interdiction, and battlefield air interdiction.

3. Discuss the use of composite force packages in the air superiority role.

Having established Air Force and Army doctrine as it applies to AirLand Operations, this paper focuses on the first of two critical areas: The threat. Selection of the future threat is a difficult task in today's rapidly changing worldwide military, political, and economic situation. The paper focusses on a modern Soviet Integrated Air Defense System (IADS) for two primary reasons. First, the Soviet IADS is accepted as the most formidable IADS in the world. Their weapons systems and command and control system are redundant and comprehensive. They have exported

all but the most modern of equipment throughout the world. Second, the premise of this paper is to cover air supremacy and AirLand Operations. The principles of AirLand Operations apply equally throughout the spectrum of conflict to include the potentially minor military operations of Low Intensity Conflict, larger military operations on the scale of Operation Desert Storm, or a major European confrontation between superpowers.

Having defined the threat, the thesis analyzes the second critical area: The current and future technology as it applies to air superiority.

1. The thesis must take into account the current status of the Advanced Tactical Fighter to include its proposed roles, missions, and capabilities.

2. Equally important is the need to discuss the future of U.S. Air Force Suppression of Enemy Air Defenses (SEAD) aircraft, including the F-4G Wild Weasel and subsequent follow on "Weasel" aircraft.

The thesis then evaluates the combination of doctrine and technology to determine current and future capability against a Soviet-style IADS. The discussion of AirLand Operations during Operation Desert Storm is designed to establish a yardstick for comparative purposes.

The thesis covers each area in detail in Chapters IV through VII. This methodology provides a complete and

logical progression of ideas culminating in a satisfactory resolution to the basic question.

## CHAPTER 3

## REVIEW OF THE LITERATURE

Review of literature indicates an abundance of valuable information on each of the topic areas identified in Chapter II, Methodology, with the exception of Operation Desert Storm. Little, however, has actually been written on the proposed question of this thesis. The purpose of this literature review is to provide a starting point for the reader who is interested in further study into this thesis question. Each of the areas of research (i.e, history, doctrine, threat, etc.) provides a piece of the answer to the thesis question but requires support from the other areas. The conclusion of this chapter discusses the relationships between the separate areas of research and their importance to the thesis question.

Air Force Manual (AFM) 1-1, Basic Aerospace Doctrine of the United States Air Force, provides the starting point for this thesis. It defines U.S. Air Force Operational, Tactical, Joint, and Combined Doctrines and outlines the basic objectives of land and aerospace forces. AFM 1-1 provides excellent definitions of air superiority and air supremacy. In addition, AFM 1-1 ties air superiority to

success of land and naval forces in battle. The Joint Chiefs of Staff Publication 1-02, Department of Defense Dictionary of Military and Associated Terms, also provides excellent definitions of air superiority and air supremacy and further defines the interrelationship between the two. JCS Pub 1-02 will serve as the reference for DOD and NATO standardized military terminology throughout this paper.

AFM 2-1, Aerospace Operational Doctrine, Tactical Air Operations - Counter Air, Close Air Support, and Air Interdiction, provides an excellent, generalized discussion on all phases of counter air operations and their applications on the modern battlefield. Information presented in AFM 2-1 is in complete harmony with the Air Force discussion presented in Army Field Manual (FM) 100-15, Corps Operations. FM 100-15 provides a thorough explanation of counter air, offensive counter air, defensive counter air, Suppression of Enemy Air Defenses (SEAD), air interdiction, and battlefield air interdiction as they are seen from the Army point of view. AFM 2-1 and FM 100-15 draw a relationship between U.S. Air Force and Army doctrines.

FM 100-5, Operations, provides the starting point for my research into AirLand Operations. FM 100-5 provides AirLand Battle doctrine, and includes thorough discussions on its fundamentals, operational and tactical planning and execution, and joint, combined, and contingency operations.

Training and Doctrine Command Pamphlet (TRADOC) 525-5, AirLand Operations, provides the evolution of AirLand Battle from its current state throughout the foreseeable future. FM 44-100, U.S. Army Air Defense Operations, provides an excellent theoretical progression through the air campaign phases. These phases begin with the denial of enemy local air superiority and conclude with the attainment of air supremacy. These four documents, FM 100-5, TRADOC PAM 525-5, FM 100-15, and FM 44-100 provide the groundwork for the U.S. Army doctrine used throughout this research project. A research project entitled "The 'Air' in the AirLand Battle" by Major James Henderson also provides an insight into Army doctrine, depicted from an Air Force point of view. These doctrinal documents establish a basis for achieving air superiority but do not tie current or future capabilities to those of the threat.

Several research reports provided a starting point for the initial research into the history of air superiority. "Air Superiority Today and Tomorrow" by LtCol Claude Blanch provides an excellent historical study of air superiority, or lack thereof, during the early stages of the Vietnam conflict. Aircraft losses from fighter engagements, Surface-to-Air Missile (SAM) engagements, and Antiaircraft Artillery (AAA) are covered in detail. "Air Superiority - Vietnam, Today, the Future" by Major George Thomas also provides an insight into the problems of gaining air

superiority in Vietnam and the detrimental effect the lack of air superiority has on the land battle. These articles discuss problems we have had in the past but do not discuss the future or how AirLand Operations will change the Air Forces' requirement to provide air superiority.

Finally, Major Michael Navarro's article, "Soviet Battlefield Air Defense Systems: Doctrinal Implications for Tactical Air Power," provides an insight into the Soviet Integrated Air Defense System (IADS). As well as covering the Korean and Vietnam experience, he provides a detailed account of aircraft losses during the Yom Kippur War, in Southwest Asia. He provides an excellent, unclassified overview of the Soviet SAM ground order of battle and highlights the importance of providing thorough suppression of enemy air defense systems.

Complete and current descriptions of the Soviet IADS are available in two primary publications. Jane's All the World's Aircraft and the annual March issues of Air Force Magazine entitled "Soviet Military Power" describe in detail Soviet leadership, doctrine, aircraft, air-to-air weapons systems and missiles, SAM systems, AAA, command and control, and order of battle for these systems. FM 100-2-1, The Soviet Army Operations and Tactics, FM 100-2-2, The Soviet Army Specialized Warfare and Rear Area Support, and FM 100-2-3, The Soviet Army Troops, Organization, and Equipment provide detailed analyses of Soviet air defense weapons

systems and doctrine. These five publications will form the initial basis for the discussion of the Soviet IADS.

Information on future Air Force systems is abundant. Initially, research is limited to articles devoted to the projection of air superiority. Topics include future air superiority fighters, stealth aircraft and technology, and the future of aircraft designed for the SEAD mission. Colonel (French Air Force) Jean-Georges Brevot's article, "The Best Investment For The Air Superiority Fighter Of The Year 2000: The Aircraft, Its Weapon System, Or Its Armament," poses a dilemma for its reader. He ponders the driving force behind the development of the next generation fighter and provides an excellent discussion on the quantitative versus qualitative problem of future air superiority fighters. Major David Rickert also discusses these issues in his article "Air Superiority Concepts: 1980-2000." Major Robert Blankert provides a more current summary of future Air Force systems in his briefing entitled "Advanced Tactical Fighter Study: An Annotated Briefing." He discusses stealth technology in detail and provides a computer analysis of stealth aircraft survivability and kill ratios over the modern battlefield. In essence, he states that future air superiority fighters must be built with stealth technology. Major John Jacobsen proposes a future "Wild Weasel" aircraft in his article "F-15E Dual Role Fighter Operational Test and Evaluation Plan." The recently

fielded, two seat F-15E is a follow on to the single seat F-15C air superiority fighter. The F-15E is currently a dual role aircraft with air interdiction and nuclear strike missions. The F-15E retains an inherent air-to-air capability and could easily be modified to fulfill the SEAD role which, until recently, was provided solely by the F-4G. Several magazines proved invaluable for research into future Air Force Systems. Aviation Week and Space Technology and Air Force Magazine provide monthly articles on current research in this area. In addition, Time and Newsweek closely follow the United States budget, in particular their effect on military appropriations.

Several good articles cover the SEAD mission. In his article "Air Superiority Force Employment -- A Tactical Option," Major Ted Moseley proposed a specialized force composed of air superiority fighters, SEAD aircraft, Electronic Warfare (EW) aircraft, and early warning aircraft designed to suppress the enemy IADS during interdiction missions. An earlier article by LtCol David Brog entitled "Defense Suppression as a Basic Operational Mission" belabored the importance of SEAD and proposed adopting it as a separate mission altogether. Major Richard McCabe's article "Counterair Operations in the deep attack: An Analysis of Feasibility" strongly supported both of these articles and provided some guidance for future research.

Analysis of Operation Desert Storm highlights the vision demonstrated by these three authors.

Three articles discuss air superiority and its importance in Airland Operations. The first article, "Air Support in CENTAG Deep Operations" by James Kahan defines the categories of tactical air support and outlines their employment in NATO's central region. The second article, "A Theater-Level View of Air Power" by General (Ret) Charles Donnelly, Jr., outlines the challenges faced by the air component commander as he fulfills the objectives of CINCENT's campaign plan. General Donnelly was a strong proponent of the air superiority mission and AirLand Operations. Finally, Sam McGowan discusses the importance of air superiority as it pertains to the sustainment of AirLand Operations in his article "Airlift and the New C-17."

Discussion of the threat is an excellent starting point for the examination into the relative importance of each of the areas of research. Jane's All the World's Aircraft and Air Force Magazine both provide excellent threat systems descriptions. However, they provide no insight into threat doctrine or organization. FM 100-2-1, FM 100-2-2, and FM 100-2-3 help complete the threat discussion by providing the human side to the overall threat analysis. Research into the threat alone, however, does little to substantiate the validity of an air defense

system. This air defense system is opposed by our friendly military forces.

Again, Air Force Magazine and Jane's All the World's Aircraft provide an excellent unclassified description of friendly weapon systems. AFM 1-1, AFM 2-1, FM 100-5, and FM 100-15, among others, bind the men and women to their machines and provide the doctrine and organization for their employment. Information from these sources provided a focus for friendly versus threat comparisons. Comparison of these two areas should not be limited to the present situation. Discussion of the history of air supremacy is required to establish the validity of this thesis. Research into future weapon systems, capabilities, and acquisition trends is essential to the conclusions of this report.

Vietnam and the Middle East provide the most thorough and modern statistics for the effectiveness of modern integrated air defense systems. Statistics from these conflicts combined with statistics from Operation Desert Storm substantiate the importance of the offensive and defensive counter air and suppression of enemy air defenses operations. This area of research will point out important trends in the "air superiority" business and provide an introduction into future weapon systems' requirements.

The most difficult problem was to find good information on Operation Desert Storm. Although numerous

articles in Time, Newsweek, and Air Force Magazine covered the Gulf War, they were not organized to provide their readers with a thorough discussion on the military problem of providing air superiority over combat forces.

In summary, the research materials analyzed have covered the various aspects of the research topic. However, none of them fully address U. S. future capabilities to project air superiority in future AirLand Operations.

# CHAPTER 4

# THE THREAT

A complete discussion of the threat involves a thorough analysis of both man and machine. The war machine designed for an air defense network entails Army, Navy, and Air Force assets and the men and women who employ them, as well as their doctrine.

The threat chapter opens with a brief description of airborne assets and their respective weapons and then describes the surface-to-air missile systems and antiaircraft artillery. After establishing the primary weapon systems, it moves to a notional command and control system we would expect to see in a modern integrated air defense system. This includes discussion of threat doctrine as it applies to the entire network. This chapter explains the strengths and weaknesses in the various weapons systems. The reader should consider these in subsequent chapters.

## The Fighters

Soviet fighter aircraft are referred to as first, second, third, or fourth-generation fighters. In addition,

next generation fighters are on the drawing boards or in various stages of development. The classified nature of these systems excludes them from inclusion in this report. Suffice it to say that the Soviets understand the importance of stealth technology and the excessive length of time required to fully develop, test, and introduce a new weapon system to the field.

Soviet first generation fighters include the MIG-15 NATO Faggot, MIG-17 NATO Fresco, and the MIG-19 NATO Farmer. These fighters were developed in the early years of the Korean War and saw action during the Vietnam conflict where they were slowly replaced by the second-generation fighters. These three fighters have been phased out of the Soviet inventory but are still seen in third world air forces.

In the air superiority role, Soviet first-generation fighters are limited to intercepts and engagements in daytime and fair weather. They do not possess on-board intercept radar systems and rely completely on ground radar control for vectors to a possible engagement area. Once in the engagement area, they are limited to rear hemisphere or stern only intercepts because of fire control and weapons systems limitations. They employ infrared guided missiles and can fire an internally mounted 23 mm cannon.[1]

Soviet second-generation fighters include the MIG-21 Fishbed and the MIG-23 Flogger. These two aircraft represented significant improvements over the first

generation fighters in performance characteristics and weapons systems capabilities. Late model variations of the MIG-23 were the first of the Soviet third-generation fighters.

### MIG-21 NATO Fishbed

The oldest of the Soviet second-generation fighters, the first MIG-21 was first introduced in the late 1950s. Fielded to replace the MIG-17 and MIG-19, the MIG-21 was designed as an improved daytime, fair weather interceptor.[2] The original MIG-21s, although armed with improved infrared guided missiles, still were limited to engagements in the rear hemisphere. The Soviets continued to modernize and upgrade the MIG-21 through its final variant, the MIG-21N.[3] In its final form, the MIG-21 possessed an improved "Jay Bird" radar capable of radar lock on to targets out to 18.5 miles. With this capability, the MIG-21 evolved into an all-weather, day or night interceptor who did not require ground control during the terminal stages of an intercept. Although armed with semi-active radar guided missiles, the MIG-21 still requires maneuvering to the rear hemisphere to engage and kill the target.

Because of the continued modernization of the Soviet air forces, only approximately 150 MIG-21s remain in first-line service in the Soviet tactical air forces.[4] However, over 1400 were exported to Soviet European

satellite countries and are still flown by over 30 countries worldwide.[5]

**ARMAMENT:** One twin-barrel 23 mm GSh-23 cannon is internally mounted. The MIG-21 can carry up to four AA-2 Atoll air-to-air missiles.[6] Generally, the MIG-21 will carry two AA-2C semi-active radar guided missiles and two AA-2D infrared guided missiles.

**STRENGTHS:** The aircraft is relatively easy to maintain and can maintain good daily sortie rates. Because of its small size, the MIG-21 is difficult to acquire visually (the average visual pick up of the MIG-21 is one to one and a half miles) and is very maneuverable in the close-in visual fight.

**WEAKNESSES:** The MIG-21 does not possess an all-aspect engagement capability. Therefore, the MIG-21 is vulnerable to engagement and destruction long before it can employ weapons, unless it can enter the combat arena undetected. If communications with ground control are interrupted, The MIG-21 will have severe problems finding and intercepting targets.

MIG-23 NATO Flogger

The Soviet air forces fielded the original MIG-23s in the late 1960s to counter the United States Air Force's F-105 Thunderchief and F-4 Phantom.[7] The F-105 and the F-4 posed opposing problems for the Soviet engineers at Mikoyan-Gurevich design bureau. The F-105 would be the

fastest aircraft of her time making speed essential for an effective interceptor. The F-4, although not slow in her own regard, was a highly maneuverable fighter armed with state of the art weapons and avionics. The MIG-23 evolved as a variable geometry wing fighter with excellent high speed dash capability but only limited maneuverability. The MIG-23B, MIG-23G, and the MIG-23K are the air-to-air variants of the Flogger. All possess the "High Lark" search and track radar which give Flogger a significant advantage over Fishbed. The radar has a fifty-three mile search capability and a thirty-four mile track capability.[8] The MIG-23 is an all-aspect fighter capable of depressed angle intercepts in the front hemisphere. In other words, Flogger may engage targets approaching head on as long as the target altitude is not significantly lower than that of Flogger or very close to the ground. Approximately 1300 Flogger remain in first line service in the Soviet tactical air forces.[9] Flogger are placed into storage as they are replaced by the newer MIG-29 Fulcrum and SU-27 Flanker air-to-air variants. In addition, at least seventeen other air forces fly the Flogger.[10]

**ARMAMENT:** One twin-barrel 23 mm GSh-23L cannon is mounted in a belly pack. Standard configuration for the MIG-23B and the MIG-23G includes four AA-8 Aphid infrared guided missiles and two AA-7 Apex semi-active radar guided

missiles. MIG-23K also carries AA-8 and AA-7 and has been seen with the AA-11 Archer on fuselage pylons.[11]

STRENGTHS: Like the MIG-21, the MIG-23 presents a small visual cross section and is difficult to pick up in a visual engagement. The MIG-23 is an extremely fast aircraft capable of chasing down virtually any aircraft laden with a full combat load of bombs and/or air-to-air missiles.

WEAKNESSES: Although the MIG-23 possesses an all-aspect, depressed angle engagement capability, it will never be a true look down/shoot down fighter in the class of the USAF F-15 Eagle or Soviet SU-27 Flanker. Targets can evade Flogger by flying in the low altitude environment below 2000 feet where they will be "hidden" by the limitations of the "High Lark" radar. In a maneuvering fight, the Flogger is no match for the F-15 Eagle or the F-16 Falcon.

MIG-25 NATO Foxbat

In a panic, the Mikoyan-Gurevich design bureau designed and produced the first third-generation MIG-25 Foxbat to counter the development of the USAF XB-70 Valkyrie supersonic bomber.[12] The XB-70 program was eventually cancelled by the USAF after a series of setbacks and the loss of one of two prototypes. Before her death, however, the XB-70 flew at altitudes over 70,000 feet at sustained speeds over Mach 3. The Soviets lost the cat and mouse game after the cancellation of the XB-70 but went ahead with development and production of Foxbat. By 1965, the MIG-25

was the highest flying, fastest fighter in the world. Based on these attributes alone, the MIG-25 was considered to be the world's finest interceptor.[13] The defection of Lieutenant Viktor I. Belenko in September 1976 would change forever our impression of this fighter. In their hurry to produce the MIG-25, the Soviet engineers relied heavily on "off the shelf" technology and essentially ended up with a low technology fighter with huge engines.

The MIG-25 has since undergone significant upgrades in avionics and is still a formidable threat to our ability to project air supremacy. Although the MIG-25 will not pose a significant challenge (with respect to kill ratios) to air-to-air fighters, it will still cause a lot of concern to the support assets such as the Airborne Warning and Control System (AWACS), RC-135 Rivet Joint, and EC-130 Compass Call aircraft. The primary problem is the MIG-25's high altitude and high speed capability. Intercept of a "high, fast flyer" is one of the most difficult intercepts to challenge air defense fighters. The smallest error in approach or mismanagement of fighter speed and altitude will result in a missed intercept. This missed intercept is very bad news, indeed for a "heavy" aircraft such as AWACS in full retreat. Destruction of these critical assets would severely hamper our ability to manage the air supremacy network.

**ARMAMENT:** Standard configuration includes one each infrared and semi-active radar guided variant of the AA-6 Acrid

air-to-air missile under each wing. Alternate configurations include carriage of the AA-7 Apex and the AA-11 Archer.[14]

STRENGTHS: High altitude and high speed are the primary strengths of the Foxbat. The F-15 Eagle and the F-14 Tomcat are the only fighters in the world that possess a reasonable capability to intercept and destroy Foxbat. The Soviet tactical air forces still employ approximately 400 Foxbat in first line service.[15] In addition, Algerian, Indian, Iraqi, Libyan, and Syrian air forces fly the Foxbat.[16]

WEAKNESSES: Out of the high-altitude environment, the Foxbat is no match for modern fighter aircraft. High-altitude, high-speed flight causes excessive heat damage to Foxbat engines. Engines exposed to speeds greater than Mach 3 must be replaced after the mission.

Fourth-generation Soviet fighters include the MIG-31 Foxhound, MIG-29 Fulcrum, and the SU-27 Flanker. These aircraft include sophisticated weapons control systems, and in the case of the MIG-29 and the SU-27, performance characteristics that match the best of western fighters.

MIG-31 NATO Foxhound

First considered as a variant of the MIG-25, the two-seat MIG-31 was the first Soviet fighter to possess a true look down/shoot down capability. Appearance is its only similarity to the MIG-25. Foxhound is not capable of achieving the high altitudes and high speeds of Foxbat.

Foxhound has an improved pulse-Doppler radar said to be capable of search and track ranges of 190 and 167 miles respectively.[17] Armed with the AA-9 Amos air-to-air missiles, the Foxhound has been developed to counter cruise missiles as well as fighter-bombers and their escorts. Foxhound also employs an infrared search and track system, improved radar warning receivers, and active infrared and electronic countermeasures which should greatly improve survivability in the air-to-air combat arena. Deployment in first line service began in 1983. Over 160 are currently operational.

ARMAMENT: Standard combat load includes four AA-9 Amos radar homing, long-range air-to-air missiles. Outboard wing pylons could support up to four AA-8 Aphids, increasing the total weapons load to eight air-to-air missiles.[18]

STRENGTHS: As a true look down/shoot down fighter, Foxhound has the capability to deny the "low" sanctuary to ingressing fighters. As a counter-cruise-missile system, the Foxhound will significantly enhance the Soviet air defense network.

WEAKNESSES: Although the MIG-31 is a significant improvement over previous Soviet fighters, it still is not in the same class as modern western fighters. Expect employment of Foxhound in the deep defense of the Soviet Union, as it has not been exported to foreign air forces.

MIG-29 NATO Fulcrum

Early in 1985, the Soviet air forces introduced the MIG-29 Fulcrum to their inventory, the first of two new aircraft which will provide a significant challenge to western air defense systems. Similar in size to the F-18 Hornet, the MIG-29 will maneuver with the best of western fighters. Flown publicly at the 1989 Paris Air Show, Fulcrum stole the show with an unprecedented display of power and maneuverability. Fulcrum has a modern pulse-doppler radar with a true look down/shoot down capability. In addition, Fulcrum has a modern infrared search and track sensor and laser rangefinder designed to complete passive intercepts unbeknownst to her prey.[19]

The Soviet Union exported Fulcrum shortly after introduction to Soviet first-line service. Air forces from Cuba, Czechoslovakia, India, Iran, Iraq, North Korea, Poland, Romania, Syria, and Yugoslavia possess Fulcrum.[20] In addition, the German Luftwaffe, following unification with former East Germany, now possess at least one squadron of Fulcrum, technicians, and aircrew. Undoubtedly, these aircraft will lead to significant exploitation by Germany and her NATO allies.

**ARMAMENT:** Standard configuration includes an internally mounted GSh-301 30 mm cannon and six air-to-air missiles on the fuselage and wing pylon stations. Fulcrum carries both the infrared and semi-active radar guided variants of the

AA-10 Alamo air-to-air missile and the infrared guided AA-11 Archer air-to-air missile. Fulcrum also has a provisional capability to carry the AA-8 Aphid and the AA-9 Amos.

STRENGTHS: Small size, excellent performance characteristics, and modern, lethal weapons bring Fulcrum to the same class as most western fighters. A sophisticated engine inlet system allows employment by Fulcrum from unimproved runways, greatly expanding her wartime deployability.

WEAKNESSES: Fulcrum avionics still lack the degree of sophistication found in modern western fighters. To some degree, the training regimen of the "Soviet" system will not allow pilots to fully exploit the capabilities of their system.

SU-27 NATO Flanker

The SU-27 Flanker is the latest and most sophisticated of the Soviet fourth-generation fighters. Flanker was developed specifically for air-to-air combat and was the first Soviet fighter to incorporate fly-by-wire flight controls. Maneuverability, like that of the Fulcrum, rivals that of all western fighters. Flanker has greater than Mach 2 capability and is very fast in the low altitude environment, giving it the capability to chase down most targets at will. Due to its large size and corresponding large internal fuel capacity, Flanker has an impressive unrefueled combat radius of over 900 miles.[21] Flanker

incorporates a track-while-scan, pulse-doppler radar system, giving her a capability to track selected targets while monitoring the movement of others. In addition, Flanker also incorporates an infrared search and track system with laser rangefinder similar to that on Fulcrum. These modern avionics are tied to the pilot's helmet-mounted sight, giving the pilot an excellent degree of freedom while employing Flanker's weapons systems. Exports of Flanker to China began in 1991.[22]

**ARMAMENT:** Standard configuration includes an internally mounted GSh-301 30 mm cannon and up to ten air-to-air missiles on the fuselage and wing pylon stations. Flanker normally carries two long-range, semi-active radar guided variants of the AA-10 Alamo and four medium-range infrared and semi-active radar guided variants of the AA-10 Alamo as well as four AA-11 Archer infrared guided missiles. Flanker also has provisions to carry the AA-8 Aphid and the AA-9 Amos.

**STRENGTHS:** Excellent maneuverability and speed, coupled with an outstanding combat radius are definitely strong suits for the Flanker. Incorporation of the pilot's helmet-mounted sight into the the entire weapons system's avionics could give Flanker a decided advantage in air-to-air combat with the most modern of western fighters.

**WEAKNESSES:** Because of its large size, Flanker is susceptible to visual acquisition once forced into a

visually maneuvering "dogfight." Again, the Soviet training regimen may not allow Flanker pilots to fully exploit their system's capabilities.

## The Air-to-air Missiles

The AA-2 NATO Atoll is the oldest of the modern Soviet air-to-air missiles and may be carried by most aircraft in the Soviet inventory. The AA-2 has been widely exported and includes the semi-active (rear hemisphere only) AA-2C variant and the infrared guided AA-2D variant.[23] Both weapons are susceptible to infrared and electronic countermeasures.

The AA-6 NATO Acrid was specifically designed for carriage on the MIG-25 Foxbat. The AA-6 is available in infrared and semi-active radar guided variants.[24] Due to maneuverability limitations in the terminal phases of an intercept, the AA-6 does not present a formidable challenge to defensively maneuvering fighters.

The AA-7 NATO Apex was designed specifically for carriage by the MIG-23 Flogger but may be carried by the MIG-25 Foxbat and the MIG-29 Fulcrum.[25] The AA-7 exists in both infrared and semi-active radar guided variants. Both weapons may be susceptible to infrared and electronic countermeasures as well as employment limitations from the MIG-23.

The AA-8 NATO Aphid is a short-range, maneuverable, infrared guided air-to-air missile, capable of carriage by most Soviet aircraft.[26] The AA-8 has a shorter range than the AA-2, AA-6, and AA-7 infrared guided variants but is more maneuverable in the visual dogfight. The AA-8 is susceptible to infrared countermeasures.

The AA-9 NATO Amos was designed to supplement the look down/shoot capability of the MIG-31 Foxhound. It is also an alternative weapon for the SU-27 Flanker. The AA-9 may incorporate semi-active radar/inertial midcourse guidance with active radar terminal guidance bringing it into the same class as the USN's AIM-54 Phoenix. The AA-9 may also be available in a passive radar homing version designed to attack AWACS.[27]

The AA-10 NATO Alamo was first seen carried by the SU-27 Flanker and may be carried on the MIG-29 Fulcrum. The AA-10 comes in four variants. The AA-10A and AA-10B are the short-burn (medium-range) infrared and semi-active radar guided variants, respectively, and are standard loads on the MIG-29 and the SU-27. The AA-10C and the AA-10D are the long-burn (long-range) infrared and semi-active guided variants, respectively, carried only on the SU-27.[28] Based on an aerodynamic analysis of the exhaust and control surfaces, the AA-10 may be one of the world's most sophisticated air-to-air missiles.

The AA-11 NATO Archer is a short-range infrared guided missile system employed by the MIG-29 and the SU-27. Its advanced control surfaces and thrust vectoring, coupled with excellent off-boresight capability and the pilot's helmet-mounted sight may give it unparalleled performance in the close-in, visual dogfight.[29]

## The Surface-to-air Missiles

From the late 1950s to the present, the Soviet military has fielded over a dozen surface-to-air missiles systems as diverse as small, tactical, shoulder-fired variants to large, fixed weapons with strategic, anti-ballistic missile capability. In one form or another, these weapons systems are incorporated into a complex integrated air defense system capable of defending the entire Soviet Union, as well as her armies deployed in the field. The Soviets have exported many of these weapons.

### SA-2 NATO Guidline

The SA-2 Guidline is the oldest of Soviet surface-to-air missile systems still in wide service throughout the Soviet Union.[30] Designed for high altitude service, the SA-2 gained its claim to fame in 1960 when it shot down an American U-2 intelligence aircraft over Soviet territory. The SA-2 saw wide service in the Vietnam conflict, particularly in and around Hanoi. The SA-2 does

not have good maneuverability in the terminal phases of an intercept and is not considered a serious threat against "aware" fighter aircraft. However, the SA-2 did successfully engage and destroy both fighters and bombers alike in the Vietnam conflict. Without success, Iraq employed the SA-2 during the Persian Gulf War. Over 2,400 SA-2s remain in first-line service within the Soviet Union but are slowly being replaced by the newer SA-10. The SA-2 has been exported to at least twenty-eight other countries. STRENGTHS: The SA-2 has capability up to 90,000 feet which covers the service ceiling of all known fighters in the world. With its maximum velocity achieved at approximately 25,000 feet, the SA-2 could pose a serious threat to AWACS, RC-135s, and other support assets deployed deep in support of Airland Operations. The SA-2 has a large, lethal warhead. All variants are land-transportable. WEAKNESSES: The SA-2 is command-guided and is susceptible to "chaff corridors" and electronic counter measures. The "Fan Song" radar associated with the SA-2 is a welcome target for "Wild Weasel" missions. Although it possesses a good high-altitude capability, the SA-2 is not effective below approximately 500 feet (higher in rough terrain) or against aggressively maneuvering targets.

SA-3 NATO Goa

In 1961, the Soviets introduced the SA-3 Goa into service. The SA-3 was designed to fill the low-altitude gap

left by the higher-flying SA-2. Smaller than the SA-2, the SA-3 has capability down to 150 feet and has improved capability against maneuverable, fighter-sized targets. As of 1990, the SA-3 was still in production. It is still employed in over 300 air defense artillery battalions throughout the Soviet Union. Exported to at least twenty-six countries outside the Soviet Union, the SA-3 received credit for five F-4 Phantom kills during the 1968-1970 Egyptian-Israeli War of Attrition.[31] Iraq possessed the SA-3 during the Persian Gulf War. The naval version of the SA-3, the SA-N-1 is widely deployed on Soviet naval surface combatants.

STRENGTHS: Completely mobile, the SA-3 may appear anywhere on the battlefield. Normal employment, however, is around high value targets such as command and control facilities or weapons storage sites. The associated "Low Blow" radar can track up to six targets simultaneously and guide up to two missiles against a single target. Because of its extensive deployment and coverage, the SA-3 can pose a significant threat to incoming fighters and bombers.

WEAKNESSES: "Aware" fighters equipped with modern countermeasures equipment and aggressive crews can still defeat the SA-3. The SA-3 is vulnerable to "Wild Weasel" missions. The SA-3 does not have capability against aircraft flying below 150 feet.

SA-4 NATO Ganef

Originally deployed in 1969, the SA-4 Ganef is a major component in the Soviet Army's integrated air defense system. Mounted on a tracked vehicle, the SA-4 is normally deployed between six and fifteen miles from the FEBA in defense of command and control facilities and other high value targets. Effective between 330 and 78,000 feet, the SA-4 provides the medium-altitude coverage for the Soviet Armies. The associated "Pat Hand" radar can guide two missiles simultaneously to the target. Over 1,300 SA-4 systems are in service with the Soviet forces. Bulgaria, Czechoslovakia, Hungary, and former East Germany received export versions of the SA-4. The Soviets are replacing the older versions with the SA-11 and the SA-12.[32]

**STRENGTHS:** Mounted on the tracked SPU mobile launcher, the SA-4 can move freely throughout the battlefield and keep pace with an advancing army. The relatively large, 300 pound warhead and proximity fuze improve the weapon's lethality.

**WEAKNESSES:** Aircraft can evade the SA-4 by flying at altitudes below approximately 300 feet. A relatively slow missile by modern standards, the SA-4 can be easily defeated by aggressive maneuvering during the terminal phases of an intercept by an "aware" fighter.

SA-5 NATO Gammon

The SA-5, like the MIG-25 Foxbat interceptor, was designed specifically to engage the XB-70 Valkyrie. Designed in the late 1950s, it has a similar mission to the SA-2. The SA-5 is a fast missile (in the Mach 4 class) and has a high altitude capability up to 100,000 feet. Throughout the years, the Soviets unsuccessfully engaged high-altitude, high-speed SR-71 intelligence aircraft with the SA-5 on several occasions. In addition, SA-5s were employed unsuccessfully against fighter aircraft during operation "El Dorado Canyon," the 1986 surprise raid on Libya by joint Air Force and Naval units. The SA-5 has both conventional and nuclear warheads. It may have an antimissile capability. In addition, the SA-5 reportedly has the capability to engage targets with a passive, anti-radiation guidance system.[33]

STRENGTHS: The SA-5 has an exceptional long range of up to 155 miles. Depending on its location in the integrated air defense system, the engagement envelope could prohibit forward deployment of AWACS and other electronic warfare aircraft. A passive engagement capability could present a problem to all emitting aircraft without warning. The 25 kiloton nuclear warhead variant will have an expectedly large lethal radius.

WEAKNESSES: The SA-5 does not have low-altitude capability below approximately 1000 feet. In addition, the SA-5 is not

normally considered a threat to fighter-sized aircraft. Because of its fixed locations, SA-5s may be avoided during ingress and egress if routes are carefully constructed during pre-mission planning.

SA-6 NATO Gainful

Fielded in the mid-1960s, the SA-6 Gainful still poses a significant threat to fighter aircraft in the 1990s. The SA-6 received credit for approximately twenty kills in the 1973 Arab-Israeli War and at least one kill in the Persian Gulf War.[34] The SA-6 is a medium-range missile system with capability between 300 and 36,000 feet. Captured specimens have been exploited. The SA-6 and the associated "Straight Flush" radar are track mounted and fully mobile on the battlefield. SA-6s are normally deployed well forward in close association with the ZSU-23-4 Shilka gun system. At least nineteen other countries employ the SA-6.

STRENGTHS: Highly mobile and placed far forward on the battlefield, the SA-6 poses a formidable problem for ingressing fighter aircraft. Flying below the SA-6 engagement envelope, fighters will be exposed to small arms fire and other very low altitude elements of the integrated air defense system. Flying above the SA-6 envelope is difficult for many fighter aircraft armed with full combat loads. The SA-6 has good capability against maneuvering fighter aircraft.

WEAKNESSES: The SA-6, like other radar guided systems, is vulnerable to "Wild Weasel" missions with anti-radiation seekers. During the 1982 Israeli-Syrian conflict, the Israelis successfully destroyed SA-6 systems with anti-radiation missiles while the SA-6s batteries guided missiles at Israeli launched drones.[35] If small arms fires are not a significant threat, fighter aircraft can evade the SA-6 by flying below its engagement envelope.

SA-7 NATO Grail

The SA-7 Grail is an infrared guided, shoulder-fired surface-to-air missile designed to be carried in the forward area by infantry troops. Originally designed to engage helicopters and other slow aircraft in the battlefield, the SA-7 has some capability against faster moving fighter aircraft. The SA-7 recorded kills in both the Vietnam conflict and the 1973 Arab-Israeli war and is still active in the Soviet inventory. Over fifty-five countries and twenty-five guerrilla/terrorist movements throughout the world employ the SA-7.[36]

STRENGTHS: Because of its small size, the SA-7 can show up almost anywhere. Soviet SPETSNAZ or similarly equipped troops could fire SA-7s at aircraft departing from or recovering to their forward operating bases. Because of its passive infrared guidance, pilots must visually acquire the SA-7 and deploy countermeasures or maneuver to defeat the missile during the terminal phase of its intercept.

WEAKNESSES: Because of its small size and seeker limitations, the SA-7 is limited to rear hemisphere intercepts after passage overhead by the targeted aircraft. For this reason, the SA-7 has a very limited capability against fast moving fighter aircraft. The seeker is susceptible to flares and has problems with direct sunlight or reflections from clouds. The SA-7 has a very small warhead and a correspondingly small lethal radius.

SA-8 NATO Gecko

First seen in 1975, the SA-8 Gecko is a short-range, all-weather, low-altitude surface-to-air missile system. The SA-8 was designed to fill the gap between the shorter range, infrared guided SA-7 and SA-9 and the medium range SA-6. With respect to radar guided surface-to-air missile systems, the SA-8 was unique as it carried all the components necessary to conduct a target engagement on a single vehicle. The SA-8 is the most mobile of radar guided surface-to-air missile systems on the battlefield. The SA-8 has capability down to eighty-two feet and up to 16,000 feet. The system is initially command guided with semi-active guidance in the terminal phases of the intercept. More than 1,000 systems are active in the Soviet armies. The Soviets have exported the SA-8 to at least fifteen countries including Iraq, Jordan, Libya, and Syria. The naval variant of the SA-8 is the SA-N-4.[37]

STRENGTHS: The "Land Role" fire-control radar associated with the SA-8 is unique as it has the capability to guide two missiles to a single target on separate frequencies. This capability severely hampers the effectiveness of electronic countermeasures. The low altitude capability down to 82 feet essentially eliminates the low-altitude sanctuary for fighters.

WEAKNESSES: The small missile has a relatively short range of only six miles. Denial of initial radar acquisition through electronic countermeasures and avoidance of the limited missile engagement envelope have proven effective against the SA-8.

SA-9 NATO Gaskin

The mobile amphibious SA-9 Gaskin has served the Soviet army for more than twenty years. The infrared guided SA-9 is normally found far forward in the battlefield with the ZSU-23-4 gun system. Each Soviet division normally possesses sixteen SA-9 transporter-erector-launchers (TELs) organized into four batteries. The "Dog Ear" radar and "Hat Box" passive radar antennas provide early warning for the SA-9. The Soviets have exported the SA-9 to over twenty armies and guerrilla forces. The Soviets are replacing the SA-9 with the improved SA-13 Gopher.[38]

STRENGTHS: Passive early warning from the "Hat Box" system and passive infrared guidance reduce pilot warning to visual acquisition of launch. Little time to react to the launch

remains after visual acquisition. The system has line-of-sight capability down to approximately thirty feet. WEAKNESSES: System range is limited to approximately five miles. In addition, the system has very limited capability during attempted head-on engagements. The small warhead has a lethal burst radius of only five feet, which significantly reduces its probability of kill.

SA-10 NATO Grumble

Designed to replace the aging SA-2, the SA-10 Grumble is an efficient all-altitude, radar guided surface-to-air missile. Currently, 25 percent of all Soviet strategic surface-to-air missile systems carry the SA-10. Mission priorities for the SA-10 include terminal defense of command and control facilities, military, and industrial complexes. Guidance consists of a track-via-missile system with an active radar seeker during the terminal phase of the intercept. Like the U.S. made Patriot missile system, the SA-10 should have capability against ballistic missiles. Although the Soviets have developed a mobile variant, do not expect to see the SA-10 forward deployed on the battlefield. STRENGTHS: Because of its high speed (in the Mach 6 class) and very low altitude capability down to eighty feet, this highly efficient surface-to-air missile system poses a significant threat to fighter aircraft. The large engagement envelope extends outward to sixty miles.[39]

**WEAKNESSES:** Few, if any weaknesses exist for a system with capabilities similar to Patriot. Denial of initial radar acquisition may be the only defense currently available for this impressive surface-to-air missile system.

SA-11 NATO Gadfly

The SA-11 Gadfly was designed to replace the SA-4 at the Soviet army level and the SA-6 at division level. The system has low altitude capability down to 100 feet and should provide defense against high performance aircraft and cruise missiles. The system contains the "Tube Arm" early warning and acquisition radar but may be incorporated into the SA-6s "Straight Flush" radar when required.[40] Similar to the SA-8, the entire system is carried on a single tracked vehicle, giving it excellent mobility.

SA-12 NATO Gladiator/Giant

The SA-12A Gladiator was designed to replace the aging SA-4 missile systems. The missile is capable of engaging aircraft and tactical ballistic missiles in the class of the US Lance. The system is carried on a single transporter-erector-launcher. The SA-12B Giant is a larger derivative of the SA-12A with a postulated capability to engage strategic missile reentry vehicles as well as aircraft and tactical missiles. Both systems are rated as all-altitude.[41]

### SA-13 NATO Gopher

The SA-13 Gopher is replacing older SA-9s in their role of forward defense of Soviet motorized rifle divisions. Like the SA-9, the SA-13 uses infrared guidance and incorporates the "Hat Box" passive radar detection system for early warning and the "Dog Ear" radar system for target ranging. Two versions of the missile are in production. The missile's seeker is an all-aspect, cryogenically cooled infrared system with excellent counter-countermeasures capability.[42] The SA-13 is replacing the SA-9 in a one for one swap in the air defense battalions. Thirteen countries have received shipments of the SA-13.

### SA-14 NATO Gremlin

The SA-14 is an infrared guided, shoulder-fired surface-to-air missile system designed to replace the SA-7. The SA-14's improved motor, warhead, and seeker give it a distinct advantage over the SA-7. The cryogenically cooled seeker is effective in forward and rear hemisphere engagements and has some infrared counter-countermeasure capability.[43] The SA-14 will provide increased lethality for Soviet infantry.

## The Antiaircraft Artillery

Antiaircraft artillery covers a spectrum from small arms to large-caliber weapons such as the S-60, 57-mm gun

system. Although other, older systems exist, this thesis only covers the S-60, ZSU-23-4, and the 2S6.

### S-60

The S-60 is a 57-mm towed, medium-altitude antiaircraft gun system. The S-60 is no longer in front line Soviet service but has been widely exported. Iraqi forces employed the S-60 in the defense of Baghdad and around airfields and other significant military targets. Although the system is radar guided, the single barrel and subsequent low rates of fire limit its effectiveness. Because of its large caliber, the S-60 can engage targets up to 25,000 feet.[44]

### ZSU-23-4 NATO Shilka

The ZSU-23-4 Shilka is the most widely deployed and respected antiaircraft gun system in the world. The ZSU-23-4 is a fully-integrated, self-propelled, radar guided gun system which combines a high rate of fire with an accurate tracking system.[45] The ZSU-23-4 has an effective altitude of approximately 15,000 feet. Thirty-one Israeli aircraft were lost to antiaircraft artillery in the 1973 Arab-Israeli war, largely due to the ZSU-23-4.[46] The ZSU-23-4 is thoroughly integrated into the modern Soviet integrated Air defense system.

### 2S6

The 2S6 is the follow-on Short-Range Air Defense (SHORAD) system to the ZSU-23-4. This new system combines

both a 30-mm gun system and a surface-to-air missile system on a single chassis.[47] The larger caliber 30-mm gun extends the range of the system beyond that of the ZSU-23-4. Little is known about the tube-launched SA-19 surface-to-air missile carried by the 2S6. Postulated capabilities include semi-active laser or infrared homing and a maximum range out to six miles. Each 2S6 carries eight SA-19 missiles.[48]

## Command and Control

Depending on the situation, command and control of an integrated air defense system will include a combination of ground-based early-warning sites, early-warning aircraft, and a series of command and control centers which eventually direct the engagement of threat aircraft by one or more of the available weapon systems.

Early warning of impending attack can come entirely from passive, electronic signal monitoring systems such as the RAMONA early-warning system. The Soviets employed RAMONA extensively along the western borders of the WARSAW PACT countries to provide continuous, passive early warning of NATO aircraft movements. The RAMONA system was "tuned" to look at specific areas of the electromagnetic spectrum. As an example, RAMONA could be tuned to look for radar emissions in the INDIA band, the standard radar band for air defense interceptors such as the F-15. F-15s departing

Bitburg AB, over two hundred miles from the nearest WARSAW PACT border, would be identified by RAMONA within moments after takeoff. Triangulation by several RAMONA sites could provide bearings, ranges, and track information for initial air defense preparations. RAMONA is not limited to detection of radar emissions. Any electronic emission, whether radar, radio, or transponder is subject to intercept and triangulation at one point or another, depending primarily on range. Emission Control (EMCON) procedures have been developed to limit the effectiveness of RAMONA type systems. Under various stages of EMCON, electronic emissions of aircraft are limited to deny early detection.

The second layer of early warning comes from a comprehensive array of early-warning radars which are generally tied to one or more surface-to-air missile systems. The "Barlock-B" target search and acquisition radar associated with the SA-5 has detection capability out to approximately 200 miles.[49] At the Front level, the "Billboard" and "Pat Hand" target acquisition radars associated with the SA-12 and SA-4 weapons systems, respectively could track targets out to eighty miles.[50] As you progress down through the army, division, and regimental levels of the soviet system, the target acquisition ranges generally decrease but the number of systems increase dramatically. Army level air defense includes those target acquisition radars associated with the SA-4 and SA-11.

Division level air defense includes the SA-6 and the SA-8 weapon systems, and finally, regimental air defense encompasses the radars associated with the ZSU-23-4, 2S6, and the SA-13.

Early warning is not limited to ground based systems. The Soviets developed the Ilyushin A-50 NATO Mainstay in the early 1970s to provide airborne early warning and control of air defense fighter aircraft.[51] Similar in concept to the United States' Airborne Warning and Control System (AWACS), Mainstay was designed to enhance the low altitude coverage of the integrated air defense system. Ground-based radar systems have blind spots in their coverage created by terrain variations such as valleys and mountains. In many cases, these blind spots are predictable and may be used to the advantage of inbound, attacking aircraft. An airborne radar system, however, does not have a significant problem with blind spots. The Mainstay can detect and track cruise missiles and low flying aircraft over both land and water. In addition, the Mainstay is designed to provide command and control to air defense fighters such as the MIG-29 and the SU-27. The coverage of these various acquisition radars is extensive and redundant. It is difficult to imagine approaching a modern integrated air defense system without some warning of your impending arrival.

After incoming aircraft have been identified, the next process is to assign a weapon system to insure their destruction. Command and control for this process is very centralized. The policy for centralized command and control for the Soviet air forces was etched in stone following the battles for Moscow and Kursk during World War II. By this time, the Soviet Air Force had determined that:

> in great defensive operations the most effective use of air power was possible with centralized control, which guaranteed operational cooperation and technical joint efforts with the ground forces.[52]

By late 1942, this centralized command and control had developed into the forerunner of the modern Soviet integrated air defense system, designed to gain and maintain air superiority over the battlefield. The development of this system was based on a Soviet analysis that indicated:

> that the large results achieved by the aggressor . . .were due not so much to the surprise of the attack . . ,as to the unpreparedness of the air forces and the air defense forces designed to repel such attacks.[53]

"The objective of the Soviet tactical air defense system is to reduce the effectiveness of enemy air attacks."[54] Their corresponding mission is to "protect ground force units and other potential targets from attacks by fixed-wing ground attack aircraft and armed helicopters."[55] Air defense doctrine is based on the following principles:

> Firepower, surprise, mobility and maneuver of air defense weapons, continuous activity by air

> defense units, aggressive action, initiative, and originality on the part of air defense unit commanders, coordination of actions between supported maneuver units and supporting air defense units and between air defense units, and all-round security.[56]

Figure 4-1 represents a notional command and control schematic for a modern integrated air defense system.[57] This notional country is divided into four Air Defense Notification Centers labeled A, B, C, and D. Each of the Sector Operations Centers would receive information from a RAMONA or a surface-to-air missile target acquisition radar as aircraft entered their respective areas of responsibility. As the Sector Operations Centers received information, they could pass it laterally to other Sector Operations Centers and forward the information to their immediate Interceptor Operations Center. Subsequently, these Interceptor Operations Centers would forward this information to a central air defense command and control center for final determination. The command and control center would determine which weapon system or combination of weapons systems should engage and destroy the targets. Mainstay also passes raid information to the air defense command and control center. In the case of a small raid, surface-to-air missile systems may be adequate to provide a high probability of kill. For larger raids, targets may initially encounter surface-to-air missiles as they cross into enemy territory, then enter a fighter engagement zone, and subsequently enter another surface-to-air missile

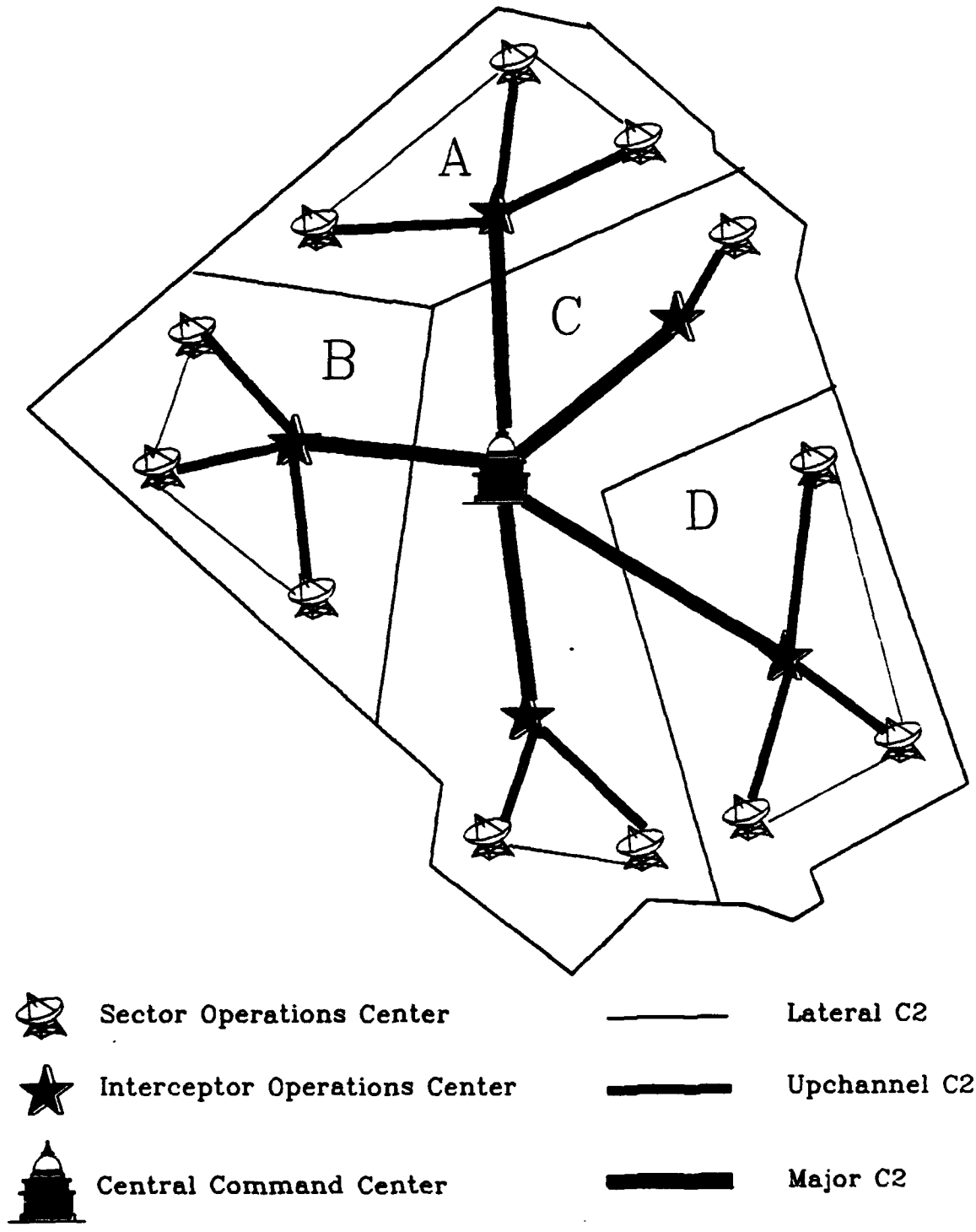


**Figure 4-1: Command and Control Network (Notional)**

engagement area as they near their targets. When required, Soviet air defense commanders will risk fratricide by intermixing his friendly fighters into "Weapons Free" surface-to-air missile engagement zones in an effort to thwart a serious air attack.

In summary, a modern integrated air defense system is a complex, highly centralized organization. Ground and air based early-warning systems provide ample warning of impending enemy raids. The centralized command and control system evaluates the raid, considers the suitability of weapons systems available for intercept, and coordinates a defensive effort to negate the attack. The number and redundancy of weapons systems in the Soviet integrated air defense system is unparalleled anywhere in the world. Likewise, countries like Iraq, Syria, and Libya modelled their systems after the Soviets and employed the latest state-of-the-art Soviet weapons systems. The system, however, is not impregnable. Vulnerabilities exist and, when treated properly, can be overcome. Chapter V reviews friendly weapons systems designed to defeat a modern integrated air defense system. Chapter VI focuses on results achieved in Operation Desert Storm and finally, Chapter VII addresses the future as both sides continue to modernize and upgrade their existing systems.

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# CHAPTER 5

# FRIENDLY ASSETS

The friendly weapons systems designed to defeat a complex and modern integrated air defense system are as diverse and complex as their targets. Because they include personnel and weapons systems from the Army, Air Force, Navy, and Marines, friendly assets require centralized command and control.

This chapter opens with a description of the fighters, those aircraft designed to intercept and destroy enemy aircraft. It then covers the aircraft responsible for providing suppression of enemy air defenses. Electronic warfare aircraft are critical in the defense suppression role and their role must be integrated with the Airborne Warning and Control System (AWACS) system. This chapter will also review the fighter bombers that will take the important interdiction role to the enemy.

## The Fighters

Fighter aircraft are those aircraft designed to intercept and destroy enemy aircraft. Some aircraft, such

as the USAF F-15 Eagle and the USN F-14 Tomcat, are designed specifically for the air-to-air mission. Other aircraft, such as the USAF F-16 Falcon and the USN FA-18 Hornet are dual role aircraft, and possess both and air-to-air capability and an air-to-ground capability. The discussion opens with a description of the F-15 Eagle, the foremost air superiority fighter in the world.

## F-15 Eagle

The F-15 Eagle is the primary air-to-air fighter for the US Air Force and is considered the best air superiority fighter in the world. Designed in the 1960s, the early F-15 "A" and "B" models entered service in the early 1970s. In 1979, the improved "C" and "D" models entered service and were also sold to air forces in Israel, Japan, and Saudi Arabia. In 1983, the USAF initiated a Multistage Improvement Program (MSIP) designed to upgrade the the avionics of all USAF owned F-15 models.[1]

The F-15 was the first fighter in the world to possess a true look down/shoot down capability over land and water from any altitude or aspect. The McDonnell Douglas Aircraft Company designed the F-15 airframe around the Hughes APG-63 pulse-doppler radar system. The overall design was truly impressive. The APG-63 pulse-doppler radar is optimized for air-to-air engagements with search and track capabilities out to 160 miles and 90 miles respectively. Equally impressive are the performance

characteristics of the airframe and engines. With a thrust to weight ratio greater than 1:1 and very low wing loading, the F-15 can fight with any aircraft in the world in the low, medium, or high-altitude environment.

ARMAMENT: Eight air-to-air missiles are carried conformally on the fuselage and under the wings. Standard configuration includes four AIM-7M Sparrow and four AIM-9M Sidewinder air-to-air missiles. The F-15 can also carry the AIM-120 AMRAAM on either the fuselage or wing stations. The aircraft also includes the M61A1 20-mm internally mounted cannon with 940 rounds of ammunition.[2]

STRENGTHS: The APG-63 radar is the best air-to-air radar in the world. The Track-while-scan radar will accurately track twenty and display ten aircraft or formations down to treetop level over virtually any terrain.[3] The raised cockpit provides outstanding pilot visibility. The aircraft can "dogfight" with any aircraft in the world.

WEAKNESSES: The F-15 is one of the largest fighters in the world and therefore subject to visual and electronic acquisition by both ground and air defenses at relatively longer ranges than most fighter or fighter-bomber aircraft. Although the avionics have remained under constant upgrade, the airframes are getting old and are no longer in production. With increasing age, the operational readiness rates will go down.

## F-14 Tomcat

The F-14 Tomcat was designed for the US Navy to provide long-range fleet air defense.[4] Like the F-15, the F-14 was conceived in the 1960s, deployed widely in the mid-1970s, and designed around a radar system. The AWG-9 radar system of the Tomcat was designed for very long range search and track and to support the AIM-54 Phoenix active radar guided missile. The airframe design, however, limits the overall performance characteristics of the aircraft. The aircraft is a true interceptor, as it has an excellent high speed dash capability and the very long-range AIM-54 Phoenix missile.

ARMAMENT: Up to eight air-to-air missiles are carried conformally on the fuselage and under the wings. Standard configuration includes four AIM-54 Phoenix on the fuselage and two each AIM-7M Sparrow and AIM-9M Sidewinder under the wings.[5] The F-14 can also carry the AIM-120 AMRAAM under the wings. The Tomcat also carries an internally mounted M61A1 20-mm cannon.

STRENGTHS: The AWG-9 radar and AIM-54 Phoenix missile system give the Tomcat the longest beyond visual range (BVR) engagement capability of any aircraft in the world.

WEAKNESSES: The Tomcat is optimized for long-range intercepts over water. Due to systems limitations, the AWG-9 radar has some difficulty during low-altitude or look down/shoot down intercepts over land. In a close-in visual

"dogfight," however, the Tomcat lacks the necessary thrust to weight ratio and turning performance to challenge modern Soviet fighters such as the MIG-29 Fulcrum and the SU-27 Flanker.

### FA-18 Hornet

The FA-18 is a multi-role carrier based aircraft flown by the US Navy and Marine Corps, and by the Canadian and Australian Air Forces. Designed and built by McDonnell Douglas, this small and versatile fighter can perform the air defense, attack, and suppression of enemy air defenses role.[6] As an air defender, the FA-18 is comparable to the F-15 Eagle. The Hughes APG-65 radar is a state-of-the-art system with an excellent look down/shoot down capability. Coupled with the AIM-7M Sparrow and the AIM-120 AMRAAM, the FA-18, like the F-15, has one of the longest beyond visual range engagement capabilities in the world. The Hornet is very agile and can compete with any fighter in the close-in visual "dogfight." As an attack aircraft, the Hornet can carry up to 16,000 pounds of varied ordnance and is used extensively by the US Marines for the close air support mission.[7] Aside from these two missions, the Navy employs the FA-18 extensively in the suppression of enemy air defenses (SEAD) role. Armed with the High Speed Anti-Radiation Missile (HARM), the FA-18 has capabilities similar to those of the F-4G Wild Weasel.

ARMAMENT: Two AIM-7M Sparrow air-to-air missiles are mounted conformally on the fuselage and any combination of four AIM-9M Sidewinder or AIM-120 AMRAAM may be carried under the wings in the air defense configuration. In the attack role, the FA-18 generally retains the AIM-7M Sparrows on the fuselage and carries air-to-ground ordnance under the wings. US Marine configurations do not have the provision to carry fuselage mounted Sparrow missiles.[8] In the defense suppression role, two HARM missiles are carried on the fuselage with air-to-ground ordnance under the wings. The FA-18 also employs an internally mounted M61A1 20-mm cannon.

STRENGTHS: The small size and versatility of the FA-18 are excellent for carrier based operations. In the defensive counter air role, the FA-18 is in the class of the F-15 Eagle. The capability to "swing" to the attack and defense suppression role provides the naval combat planner a great degree of flexibility.

WEAKNESSES: The engine design of the Hornet leaves it under powered in the high altitude environment. Moderate weapons loads reduce the low altitude maneuverability considerably.

## Suppression of Enemy Air Defenses Aircraft

### F-4G Advanced Wild Weasel

This highly modified F-4E was specifically designed for the defense suppression role. During the Vietnam

conflict, the US Air Force developed the Wild Weasel mission to help suppress SA-1 and SA-2 missile engagements over North Vietnam. The original Wild Weasels flew the F-105 Thunderchief and used crude radar warning receivers to help locate the attacking surface-to-air missile batteries. The F-4G Advanced Wild Weasel (herein referred to simply as a Wild Weasel) is a quantum leap from the early Vietnam days. The F-4G carries a state-of-the-art AN/APR-47 electronic warfare suite designed to detect, identify, and locate enemy radar systems and then direct anti-radiation missiles for their destruction.[9] The F-4G works in "hunter-killer" teams, generally consisting of one F-4G and one F-16C. The F-4G is the "hunter" with the AN/APR-47 and either fires its own anti-radiation missiles as the "killer" or directs those of the F-16C.

ARMAMENT: Standard configuration includes two AGM-45A Shrike or two AGM-88A HARM defense suppression missiles and an AIM-7M Sparrow on the fuselage and up to four AIM-9M Sidewinder missiles under the wings.

STRENGTHS: The F-4G Wild Weasel is the only aircraft in the world that can precisely identify, locate and engage an enemy threat radar system without external support.

WEAKNESSES: The F-4 airframe was designed in the mid-1950s and has been out of production since the 1970s. Consequently, the airframes are getting very old. Although the avionics are modern and state-of-the-art, the life of

the airframe is limited, at best. Approximately 70 F-4Gs remain in active service for the US Air Force.

## The Fighter-Bombers

### The F-16 Falcon

The F-16 is one of the most versatile fighter aircraft ever designed for the U. S. Air Force. Originally designed to replace F-4s in active duty and to modernize the reserve forces, the F-16 is capable of flying air-to-air, air-to ground (conventional and nuclear), and defense suppression missions. In the air-to-air role, the F-16's has excellent speed, maneuverability, and firepower. Combined with its small size and Westinghouse APG-68 multimode radar it is matched by few fighters in the world. In the air-to-ground role, the F-16 carries a wide variety of weapons ranging from precision guided Maverick air-to-ground missiles to standard free fall gravity bombs. The state-of-the-art targeting computer in the F-16 helps reduce the circular error probable (CEP) of many of its free fall weapons to single digits. The F-16 routinely wins the Air Force's semi-annual Gunsmoke bombing competition. Flying in combination with the F-4G Advanced Wild Weasel, the F-16 has a limited capability in the suppression of enemy air defenses role.

**ARMAMENT:** The F-16 normally carries two wingtip mounted infrared air-to-air missiles and a wide variety of other weapons on any of seven other external wing mountings. Later C and D model aircraft can carry the AMRAAM and the AIM-7 Sparrow. The F-16 has an internally mounter M61A1 20-mm cannon with 500 rounds of ammunition.[10]

**STRENGTHS:** The F-16's versatility, small size, and overall performance characteristics give it true multirole capability. As F-16 units continue to receive the Advanced Medium Range Air-to-Air Missile (AMRAAM) the aircraft will finally achieve true all aspect look down/shoot down capability. The F-16 is very reliable and is capable of high aircraft turn around rates and sortie generation.

**WEAKNESSES:** Although capable of carrying a wide variety of weapons, the F-16 is very drag dependent. In other words, the addition of differing weapons loads can significantly reduce the aircraft's combat radius. For conventional air interdiction missions, the weapons load can be reduced significantly because of this drag dependence.

### The F-111 Aardvark

Designed in the late 1950s, the F-111 entered Air Force service in October 1967 and has served with distinction since then. Designed to fulfill the long-range conventional and nuclear interdiction role, four F-111 variants eventually entered service. Forty-two A models were eventually converted to the EF-111A Raven electronic

combat aircraft.[11] One hundred and six F models, the latest of the F-111 series, were produced which have an excellent night, precision guided weapon, deep interdiction capability. F-111F missions flown in Operation Desert Storm were instrumental to the offensive counter air campaign. Some F-111D/F models will receive the Pacer Strike aircraft enhancement program designed to improve navigation and weapons circular errors probable.[12]

ARMAMENT: The F-111 can carry a wide variety of air-to-ground weapons including up to six nuclear bombs loaded on the wings and in an internal bomb bay. The F-111 has provisions to carry infrared guided air-to-air missiles for self defense. The F-111 can carry up to 25,000 pounds of external stores.

STRENGTHS: The F-111 can carry a wide variety of payloads over a large combat radius. Its capability to self designate or "buddy lase" targets give it exceptional deep interdiction capability with precision guided weapons.

WEAKNESSES: The F-111 is a relatively old aircraft and has no inherent stealth capability. Without suppression of enemy air defense and escort fighters, the F-111 is relatively easy prey for an advanced integrated air defense system. For this reason, F-111 missions flown during Operation Desert Storm were flown at night with associated support aircraft.

## The F-15E Strike Eagle

Although officially a variant of the original F-15 Eagle, the F-15E is a completely new aircraft altogether. Designed around a crew of two, this multirole aircraft is designed to supplement and eventually replace the F-111. The F-15E was primarily designed to provide conventional and nuclear air-to-surface support with the emphasis on air interdiction. It can also support defensive counter air missions with its inherent air-to-air capability and when specifically retrofitted, fly suppression of enemy air defenses missions.[13] The F-15E's ring-laser gyro navigation and coupled terrain following guidance systems give it outstanding capability to penetrate at night in all weather at very high speeds. The wide field of view Heads Up Display (HUD) enhances pilot performance in all phases of flight.[14]

ARMAMENT: The F-15E can carry the full compliment of air-to-air missiles including the AIM-7, AIM-9, and AMRAAM mounted conformally on the fuselage or under the wings. The aircraft can carry up to 24,500 pounds of air-to-ground ordnance either conformally or under the wings.

STRENGTHS: The inherent air-to-air capability of the F-15E gives it the capability to provide its own defense against attacking enemy interceptors. The F-15E can carry a large payload over an extended combat radius.

WEAKNESSES: Original plans called for procurement of two hundred F-15Es. Currently, seventy-two have been purchased and are in operation in either training or operational squadrons. Dwindling military budgets may prevent future purchases, thereby severely limiting the number of aircraft available for combat.

### The F-117 Night Hawk

Finally unveiled to the public in 1988, the F-117 has been operational since October 1983. Although most details still remain shrouded in secrecy, the F-117 can be called the first true stealth fighter. The aircraft's surface is made of composite radar-absorbent materials which, when painted black, reflect little light. The engine air intakes and exhausts are located above the wings and rear fuselage and significantly reduce the potential for infrared detection from ground forces.[15] "The F-117 is a one-mission aircraft . . . flown autonomously at night, to go after high-priority targets with pinpoint accuracy."[16] No details on the weapons load or targeting system are available.

ARMAMENT: Unclassified film footage from Operation Desert Storm indicated the use of precision guided weapons by the F-117. These weapons are carried in an internal bomb bay.

STRENGTHS: The stealth characteristics of the F-117 give it the capability to attack targets with virtual impunity from an integrated air defense system.

**WEAKNESSES:** The F-117 is not inherently fast or agile. If an attacking interceptor or ground defense system could maintain visual contact with the F-117, it would be a relatively easy target for destruction.

## Electronic Warfare Aircraft

### The RC-135 Rivet Joint

The RC-135 is a specially modified KC-135 Stratotanker designed to provide electronic reconnaissance in a given theater of operations. The actual capabilities of the RC-135 remain classified. The RC-135 provides real time electronic reconnaissance and intelligence data to theater and tactical commanders in coordination with the Airborne Warning and Control System (AWACS), EF-111A, and the EC-130.[17]

### The EC-130 Compass Call

The EC-130H Compass Call is a specially modified C-130 designed for communications jamming. Sixteen EC-130s are in service with the U. S. Air Force.[18] Again, the specific capabilities of this aircraft are shrouded in secrecy. During Operation Desert Storm, the EC-130 played a vital role in "disrupting Iraqi military communications at strategic and tactical levels."[19]

### The EF-111A Raven

The EF-111A is a specially modified F-111A airframe designed to provide electronic defense suppression. EF-111A missions include barrier standoff jamming, close in jamming of acquisition radars, and direct support jamming for deep operations.[20] The net effect of the EF-111A is to provide a cloaking effect for those aircraft that otherwise do not possess an inherent stealth capability. EF-111A were used very effectively during Operation Desert Storm.

### The E-3B/C Sentry

More commonly referred to as the Airborne Warning and Control System (AWACS), the E-3B/C is a "mobile, flexible, survivable, and jam-resistant surveillance and command and control, and communications ($C^3$) system."[21] The AWACS is an E-3 airframe specially modified with a domed Westinghouse radar capable of all-altitude surveillance over land or water. AWACS played an important role in Operation Desert Storm, providing key command and control and deconfliction of thousands of coalition aircraft while maintaining vigilance over Iraqi airspace.

## Air-to-air Missiles

Three air-to-air missiles deserve special attention in this paper. Two of these missiles, the AIM-7 Sparrow and the AIM-9 Sidewinder have seen wide service in both U. S.

and foreign militaries. The third, the AMRAAM, has just entered service in the U. S. Air Force and Navy.

### AIM-7 Sparrow

The radar guided AIM-7 Sparrow is one of the most lethal air-to-air missiles in the world. Carried on the F-4, F-14, F-15, F-18, and modified F-16s, the AIM-7 allows medium-range attacks in all weather from any aspect. The latest variants, the AIM-7M and AIM-7P/RIM-7P incorporate improved performance in look down/radar clutter situations and provide a real capability against sea-skimming anti-ship missiles and cruise missiles.[22] AIM-7s claimed the majority of air-to-air kills in Operation Desert Storm.

### AIM-9 Sidewinder

The AIM-9 Sidewinder is a close-range infrared guided air-to-air missile capable of carriage on almost every fighter type aircraft in the Air Force and Navy inventory. The latest variants, the AIM-9L and the AIM-9M provide all aspect intercept capability during short-range engagements.[23] When employed within parameters, these weapons have a very high probability of kill.

### AIM-120A AMRAAM

The AMRAAM has been designed to replace the AIM-7 Sparrow as the primary medium-range radar guided missile. The advantage of the AMRAAM is that it is an active radar guided missile which is capable of providing its own guidance in the terminal phases of an intercept. This

relieves the attacking aircraft of the responsibility to provide terminal guidance, allowing it to engage subsequent targets or take defensive action against attacking interceptors or surface-to-air missiles. The net result is less exposure to enemy defenses while maintaining relatively high probabilities of kill. Over four hundred and fifty AMRAAMS have been funded for production.[24]

The U. S. military, in particular the U. S. Air Force, possess an excellent compliment of fighter, fighter-bomber, weapons, and support aircraft capable of attacking and defeating any challenging air force in the world. Chapter VI analyzes the performance of these weapons systems during Operation Desert Storm. Each system played a key role in this demanding air campaign. If conflicts arise in the future, their services will again be required to project air supremacy over their enemy's airspace.

## CHAPTER 5 NOTES

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## CHAPTER 6

## AIR SUPREMACY AND OPERATION DESERT STORM

### Introduction

Operation Desert Storm opened on the evening of 15 January 1991 with a concentrated joint and combined coalition air attack throughout the Iraqi countryside. Planning for this attack began many months prior.

The key to the plan was U.S. Air Force doctrine. Doctrine directed planners to the first priority of all air attacks -- Gain control of the aerospace environment.[1] With this objective in mind, planners concentrated on the projected capabilities of both the Iraqi and coalition air forces. This chapter looks at U.S. Air Force doctrine and highlights the events which led to the eventual destruction of the Iraqi integrated air defense system. The destruction of the Iraqi defenses led to coalition air supremacy and the subsequent ability of coalition air forces to attack at the time and place of their choosing for the remainder of Operation Desert Storm.

Consider carefully the doctrine, threat, and coalition forces presented here as they lined up on the eve of combat. A detailed description of threat capabilities

was covered in chapter four. Friendly forces were covered in chapter five. One constant remains throughout the remainder of this paper -- U.S. Air Force doctrine.

## Doctrine

> The first consideration in employing aerospace forces is gaining and maintaining the freedom of action to conduct operations against the enemy. An air commander usually gains this freedom by taking the necessary steps to control the aerospace environment. Control of the aerospace environment gives commanders the freedom to conduct essential attacks which can neutralize or destroy an enemy's warfighting potential.[2]

Air superiority gives commanders freedom of action to perform all combat missions over enemy airspace and denies the enemy use of our airspace. Air superiority also gives surface commanders tactical flexibility in conducting operations without interference from enemy air forces. Finally, air superiority gives commanders freedom of action as they conduct strategic attacks into the enemy's heartland. To conduct these strategic attacks, air forces must successfully penetrate the threat environment. The speed, range, and flexibility of coalition air forces combined with their tactics, strategy, and deception led to the destruction of the Iraqi integrated air defense system.

Several missions are fundamental to gaining and maintaining air superiority. Counter air missions are flown offensively and defensively and are designed to gain control

of the air. Defensively, they are designed to prevent air attacks on friendly forces in the air, on the land, or at sea. Offensively, they are designed to engage and destroy enemy fighter aircraft attempting to intercept friendly aircraft as they perform their various missions. Offensive counter air also seeks to attack an enemy's air force potential while it is still on the ground. This can best be achieved by destroying parked aircraft, command and control facilities, POL, and weapons storage facilities, among others. These areas are usually heavily defended by surface-to-air missiles and antiaircraft artillery.

Suppression of enemy air defenses aircraft are specifically designed to negate the affects of area and point defenses. This mission, flown by both electronic jamming aircraft and fighter-bombers is and will remain critical to the air superiority mission of the Air Force. Essential then to Air Force doctrine is our ability to formulate air superiority "packages" entailing fighter, fighter-bomber, defense suppression, and electronic warfare aircraft. These "packages" attacked the critical components of the Iraqi integrated air defense system and will be required in future conflicts.

## The Iraqi Air Defenses

By the eve of Operation Desert Storm, Iraq had developed a comprehensive integrated air defense system based on Soviet design and equipped with both Soviet and western equipment. Soviet concern over a powerful air defense system began during the early phases of World War II. Early victories of the Wehrmacht in Poland and western Russia were preceded by tremendous air attacks -- air attacks that the Soviet air defenses were unable to repel. Subsequent analysis of these and other air attacks indicated "that the large results achieved by the aggressor . . . were due not so much to the surprise of the attack, . . . as to the unpreparedness of the air forces and the air defense forces."[3] Consequently, the Soviets developed their initial concept of an integrated air defense system. The system included both ground and air defense forces and a centralized command and control system designed to coordinate their actions. With respect to the centralized command and control system, the Soviets felt that "in great defensive operations the most effective use of airpower was possible with centralized control, which guaranteed operational cooperation and technical joint efforts with the ground forces."[4] This integrated command and control system was firmly in place by the battle of Kursk, between German and Soviet forces in the fall of 1943.

Soviet Frontal Aviation claimed over 1500 air-to-air kills and killed over 3700 aircraft on the ground. Soviet ground air defenses claimed over four times as many kills as did their fighters.[5] The integrated air defense system was firmly implanted into Soviet military doctrine.

Doctrinally, the Iraqi integrated air defense system duplicated that of the modern Soviet system. The only distinguishing factor between the respective Iraqi and Soviet systems was the state and nature of the weapons systems. Table 6-1 highlights the weapons systems available to the Iraqi air defense system on the eve of Operation Desert Storm.

| Fighter Aircraft | Air-to-Air Missiles |
|---|---|
| MIG-21 | AA-2 |
| MIG-23 | AA-6 |
| MIG-25 | AA-7 |
| MIG-29 | AA-8 |
| Mirage F-1 | |
| **Antiaircraft Artillery** | **Surface-to-Air Missiles** |
| ZSU-23-4 | SA-2 |
| 57MM | SA-3 |
| Small Arms | SA-6 |
| | SA-7 |
| | SA-8 |
| | SA-9 |

**Table 6-1: Iraqi Air Defense Weapons Systems**

Predominantly Soviet, the weapons are relatively old with exception of the MIG-29. The system, however, was very comprehensive. Over 750 fighter aircraft provided responsive air cover throughout Iraqi airspace, limited only by the location of airfields and the range of the respective

aircraft. Some 16,000 surface-to-air missiles provided point coverage around potential targets such as military positions, SCUD missile launch sites, chemical production facilities, airfields, and cities. Over 7,000 antiaircraft artillery pieces dotted the countryside. Small arms used in air defense were everywhere.[6]

## Coalition Forces

Defeat of this comprehensive air defense system depended on the coalition's capability to destroy Iraqi fighter aircraft and surface-to-air missiles and to disrupt their command and control system. Following their destruction or neutralization, coalition aircraft would be free to target the remainder of Iraq's air force and complete their quest for air supremacy. Table 6-2 highlights the weapons systems available to the coalition air forces on the eve of Operation Desert Storm.

| Fighter Aircraft | Offensive Counter Air |
|---|---|
| F-14 | F-15E |
| F-15 | F-16 |
| Mirage 2000 | F-18 |
| | F-111 |
| | F-117 |
| **Defense Suppression** | **Electronic Warfare** |
| F-4G | EF-111A |
| F-18 | RC-135 |
| | EC-130 |
| | AWACS |

**Table 6-2: Coalition Counter Air Aircraft**

These aircraft represent the state of the art for any comparable weapon system in the world.

## The Battle for Air Supremacy

The battle for air supremacy began as the first weapons fell on Iraqi soil. Objectives of the air campaign included:

1. Establish air superiority.
2. Isolate the Iraqi leadership.
3. Destroy nuclear, biological, and chemical production and storage facilities.
4. Destroy Iraqi offensive military capability.
5. Drive Iraqi forces out of Kuwait.[7]

Specific objectives to establish air superiority included:

1. Destroy command and control facilities.
2. Interrupt communications links between specific military and civilian command and control centers.
3. Destroy the Iraqi electrical power network.
4. Destroy Iraqi air superiority fighters.
5. Destroy Iraqi airfields.
6. Destroy the Iraqi surface-to-air missile system.
7. Destroy Iraqi POL facilities.[8]

On the outside, the air campaign designed by General Horner, the Joint Force Air Component Commander, and his

staff appeared rather simple. First, they planned to disrupt the Iraqi command and control system. With the command and control system in disarray, they planned to destroy the Iraqi air defense aircraft with the coalition air superiority fighters and to neutralize the Iraqi surface-to-air missiles with a combination of electronic warfare aircraft and defense suppression fighters. If the integrated air defense system was destroyed, they planned to apportion all capable coalition aircraft to the destruction of the remaining Iraqi air forces, ground forces, SCUD missile sites, and chemical weapons production and storage facilities.

Disruption of the command and control system was first on the list, and was prosecuted by deception and pinpoint targeting. Stealth technology was essential during this phase. Two critical weapons systems provided the necessary firepower; Naval Tactical Land Attack Missiles (TLAM) and the F-117 Stealth Fighter. Both of these weapon systems targeted Iraqi command and control centers at various points along their centralized command network. Their objective was to destroy specific centers, destroy lateral communication between other centers in the network, and force still others into autonomous operations. Stealth technology was critical as it permitted attack through the existing defense system without detection. Denial of lateral communications between selected command centers

isolated the Iraqis from the "big picture" of the attack. The deception plan added further confusion.

In essence, several aircraft, flown on specific routes through areas still serviced by a command and control center, would be reported by each up the remaining centers as a separate attack. Thousands of aircraft flew on the first night of Operation Desert Storm. Reports of aircraft attacks funnelled up the command and control chain to the central command center probably indicated tens of thousands of aircraft. The Iraqi command and control system was overwhelmed. Air defense weapons systems moved to autonomous operations, opening the way for the second portion of the air campaign.[9]

Key to the destruction of the Iraqi fighter aircraft and surface-to-air missiles were coalition air superiority "packages." These packages included air superiority fighters, suppression of enemy air defense aircraft, electronic warfare aircraft, and offensive counter air aircraft. These carefully designed and orchestrated formations of aircraft disrupted all portions of the Iraqi integrated air defense system. A standard package spread over a volume eight to ten miles wide, forty miles long, and 20,000 feet in altitude. Electronic warfare aircraft played a critical role.

The RC-135 Rivet Joint aircraft provided real-time intelligence on electronic threats that could have

threatened coalition aircraft.[10] In essence, they electronically eavesdropped on the Iraqi defense network. They, in turn, passed information to the EC-130 Compass Call aircraft who subsequently jammed Iraqi military communications at both the tactical and strategic level.[11] The net effect of these two aircraft was to find out who was talking to whom and then interrupt their communications. EF-111A Raven aircraft completed the electronic storm. Their mission was to provide area jamming coverage of the Iraqi surface-to-air missile's search and targeting radars, allowing the air superiority fighters and offensive counter air fighters to enter the combat area unmolested by tactical defenses. In the words of one Raven crewmember, their mission was to "pour electrons into [the enemy's] target-acquisition radars so he just doesn't know where you're coming from."[12]

While the electronic warfare aircraft prosecuted their electron battle, the fighters and fighter bombers entered the arena. Air superiority aircraft led the packages. The primary air-to-air aircraft, due both to its relatively long-range capability and superior weapon system, was the F-15. Its sole mission was to destroy Iraqi fighter aircraft attempting to engage the attack packages. Throughout the Desert Storm war, no Iraqi fighter successfully engaged a coalition aircraft, a tribute to the F-15 community. F-15s claimed all but one of the Desert

Storm air-to-air kills. Following close behind the F-15s, F-4G and F-16 "Hunter Killer" teams searched for Iraqi surface-to-air missile systems who were autonomously looking for targets. The F-4Gs and F-16s fired HARM and SHRIKE anti-radiation missiles at those surface-to-air missiles systems willing to radiate, either destroying them or forcing them to shut down to prevent destruction. Having shut down the Iraqi fighters, surface-to-air missiles, and command and control system, the time was right to begin the complete destruction of the Iraqi air force. Those aircraft designed to complete the quest for air supremacy included the F-16, F-15E, F-111D/F, and the F-117. Each aircraft had a specific type of target for which it was best suited.

F-117s continued to attack command and control centers throughout the remainder of the air campaign. They also moved their attacks to commercial institutions such as telephone exchanges and television/radio stations in an effort to isolate the Iraqi leadership from the rest of the world. Under the cover of darkness and stealth technology, coalition air forces systematically destroyed hundreds of aircraft stored inside hardened aircraft shelters, previously thought of as a sanctuary by the Iraqi air force. F-111s also contributed to the "shelter busting" campaign as well as targeting Iraqi tanks in their own "tank busting" campaign. F-15Es attacked all of these targets throughout the air campaign. As the campaign wore on and political

pressures began to affect targeting decisions, the F-15Es began to concentrate solely on finding and destroying SCUD surface-to-surface missiles. These aircraft concentrated their attacks during the night. During the day, the primary offensive counter air attack fighter was the F-16.

Usually escorted by a large contingent of air superiority, defense suppression, and electronic combat aircraft, the F-16s attacked relentlessly throughout the daylight hours. Their primary targets included aircraft parked on open ramps, POL facilities, and those base facilities associated with the generation of aircraft sorties and weapons systems. Accordingly, the Iraqi air defense system fell prey to attack twenty-four hours a day. It did not withstand the strain for long. Coalition forces claimed local air superiority within hours of the initiation of hostilities. Within fourteen days, the coalition claimed air supremacy over the entirety of Iraq.[13] Following this date, the only Iraqi aircraft that flew were those attempting to flee to Iran. Some of them, as well, were shot down by coalition fighters.

The coalition air forces followed their campaign to the letter. They successfully destroyed command and control centers and isolated the Iraqi leadership from critical wartime intelligence. They attacked and destroyed Iraqi aircraft in the air and under the cover of hardened aircraft shelters. They suppressed or destroyed the Iraqi

surface-to-air missile network and associated radars. Finally, they attacked those remaining targets normally associated with an integrated air defense system. In accordance with established air force doctrine, they won the battle for control of the aerospace environment. Is it logical to assume the United States forces could expect the same results in future conflicts?

As the thesis moves into the next chapter, remember the forces that fought in Operation Desert Storm. Although acknowledged as the fourth largest military in the world, the Iraqis were not necessarily endowed with the most modern of equipment. Only one of their air superiority fighters, the MIG-29 Fulcrum, could compete respectably with the F-15. In addition, the air-to-air missiles carried by the Fulcrum and other Iraqi fighters were based on older technology and could not compete effectively with modern countermeasure systems. Although very numerous, the preponderance of Iraqi surface-to-air missiles were based on fifteen year old technology. Finally, the Iraqi air force, for some unknown reason, failed to put up much of a fight against the coalition air attack.

In contrast, the coalition air forces consisted of the most modern and sophisticated aircraft in the world. Categorically, in numbers, technology, doctrine, capability, and aircrew training, the coalition air force outclassed the Iraqis. In the future, this all could change.

## CHAPTER 6 NOTES

[1]U.S. Air Force, AFM 1-1, Basic Aerospace Doctrine of the United States Air Force (Washington: Government Printing Office, 1984), 2-11.

[2]Ibid, 2-11.

[3]P. S. Kutakhov, "Experience in Fighting for Strategic Air Supremacy During the Years of World War II and its Importance in the Contemporary Situation," VOYENNO-ISTORICHESKIY ZHURNAL in Russian No 12 (December 1984): 21.

[4]John J. King, "Soviet Air Combat Experience: The Soviet Air Force in Support of Ground Forces in World War II" (Research Report, Air War College, 1978), 18.

[5]William J. Dalecky, "Battlefield Air Interdiction by the Luftwaffe at the Battle of Kursk - 1943" (MMAS Thesis, US Army Command and General Staff College, 1980), 42.

[6]Buster C. Glossen, "Desert Storm Air Campaign," briefing given to Command and General Staff College, Fort Leavenworth, Kansas, 8 April 1992

[7]Ibid.

[8]Ibid.

[9]Ibid.

[10]Robert S. Hopkins, "Ears of the Storm," Air Force Magazine 75, No. 2 (February 1992): 41.

[11]James W. Canan, The Electronic Storm," Air Force Magazine 74, No. 6 (June 1991): 28.

[12]Ibid, 28.

[13]Buster C. Glossen, "Desert Storm Air Campaign."

# CHAPTER 7

## FUTURE OF AIR SUPREMACY

### Introduction

This chapter analyzes the future of the U. S. military's capability to project air supremacy over an enemy's territory. No potential enemies or battlefields have been identified. Two trends in the world situation are critical to this chapter. The first is the status of the Soviet Union. The second is the precarious status of the U. S. military forces.

Although the Soviet Union has undergone significant change in the past two years and is not considered a primary threat to the United States, its ability to produce and export modern weapons systems is a constant concern for military planners. In previous years, the Soviets maintained very close control over the export of their newest weapons systems. When a new weapon system was fully developed and tested, it was generally fielded only into Soviet forces, and in many cases, only those forces stationed inside the Soviet Union. As the weapon system matured and its numbers expanded, the weapon system could

achieve export status, depending on its military sensitivity and the current military and political situations.

Iraq was an excellent example of a country that benefitted from weapons exported from the Soviet Union. The Iraqi integrated air defense system was based almost solely on Soviet military equipment. With few exceptions, the Iraqi integrated air defense system also included the best Soviet equipment available for export. Comparison of Iraqi equipment, covered in chapter six, to the Soviet equipment, discussed in chapter four, yields a significant difference. Although the Iraqis had the best equipment available for export, it was not, by far, the best equipment available.

The trend in the export of Soviet military equipment is not positive from the standpoint of U. S. military planners. The export of several new weapons systems in recent years indicates a new liberal attitude in Soviet weapons proliferation. Export of the MIG-29 Fulcrum began shortly after its unveiling at the 1989 Paris Air Show. Export of the SU-27 Flanker to China so soon after its introduction to Soviet forces supports this theory, as well. Export of the AA-10 Alamo and the AA-11 Archer air-to-air missiles, potentially some of the best air-to-air missiles in the world, has forced major changes in tactics in western world air forces. It is highly possible, given the economic status of the Soviet Union, that the Soviets will expand and accelerate their proliferation of modern weapon systems in

an effort to produce the revenue so badly needed in other sectors of their government's budget. Potentially, the next adversary of the United States could be equipped with state-of-the-art Soviet equipment.[1] If so, how would the United States fare against this new technology?

The answer to this question depends upon the status of the U. S. military forces, particularly those of the Air Force. Like the other services, the Air Force is getting smaller and to many observers, at an alarming pace. By 1995, the Air Force could consist of twenty-six fighter wings, down from the projected thirty-six, planned just three years ago.[2] As the Air Force "modernizes," some critical programs may be cancelled or placed on hold. The impact of these changes will be considered as this chapter analyzes the question; **Can we achieve air supremacy in future AirLand Operations?**

More than likely, doctrine will not change. Air Force doctrine was tested during Operation Desert Storm and proved sound. Air force planners prepared for and secured control of the aerospace environment, first by neutralizing the Iraqi integrated air defense system and then by destroying the balance of the Iraqi air force. Those aircraft allocated for air-to-air combat, suppression of enemy air defenses, electronic combat, and offensive counter air missions all performed admirably. In future conflicts, the performance of these or similar aircraft will be

critical as we attempt to gain air supremacy. Table 7-1 compares U. S. weapons systems employed during Operation Desert Storm to those likely available in the year 2000.

| | Desert Storm | Year 2000 |
|---|---|---|
| Fighters | | |
| | F-14 | F-14 |
| | F-15 | F-15 |
| | | ATF |
| Defense Suppression | | |
| | F-4G | F-18 |
| | F-18 | F-15E |
| Offensive Counter Air | | |
| | F-15E | F-15E |
| | F-16 | F-16 |
| | F-18 | F-18 |
| | F-111 | F-117 |
| | F-117 | |
| Electronic Warfare | | |
| | EF-111A | EF-111A |
| | RC-135 | RC-135 |
| | EC-130 | EC-130 |
| | AWACS | AWACS |

**Table 7-1: Friendly Aircraft Comparison: Desert Storm to Year 2000**

Only minor changes are indicated between Operation Desert Storm and this prediction for the year 2000. The ATF, if fielded, will probably not reach operational status until the year 2002.[3] The F-15E, used in the defense suppression role is postulated to fill the gap created by the decommissioning of the few remaining F-4Gs. Essentially, we will fight in the year 2000 with the same, or lesser, forces than we did in Operation Desert Storm. Table 7-2 compares those weapons systems employed by the

Iraqi integrated air defense system to those potentially available to an adversary in the year 2000.

| | Desert Storm | Year 2000 |
|---|---|---|
| Fighters | | |
| | MIG-21 | MIG-23 |
| | MIG-23 | MIG-25 |
| | MIG-25 | MIG-29 |
| | MIG-29 | MIG-31 |
| | Mirage F-1 | SU-27 |
| Surface-to-air Missiles | | |
| | SA-2 | SA-5 |
| | SA-3 | SA-6 |
| | SA-6 | SA-8 |
| | SA-7 | SA-10 |
| | SA-8 | SA-11 |
| | | SA-12 |
| | | SA-13 |
| | | SA-14 |
| | | SA-19 |

**Table 7-2: Integrated Air Defense System: Iraq vs Modern Soviet Equipment**

Significant changes are indicated for both aircraft and surface-to-air missile systems. By the year 2000, U. S. military forces could face state-of-the-art Soviet equipment. The remainder of this chapter will analyze the U. S. military's capability to perform the air superiority, suppression of enemy air defenses, electronic combat, and offensive counter air missions in the year 2000. Discussion will cover changes in technology, age of equipment, availability of equipment, and potential apportionment and allocation of aircraft.

## Air-to-air Combat

Destroying enemy aircraft in the air is the business of the air superiority fighter. Today's best fighters demand a combination of power, agility, technology, and advanced weaponry. Today, the world's premier air-to-air fighter is the F-15 Eagle.

During Operation Desert Storm, the F-15 outclassed the Iraqi MIG-21s, MIG-23s, MIG-25s, and the Mirage F-1 in every category of performance. Only the Iraqi MIG-29 could compete with the F-15, and then only with its power and agility. Technologically, the MIG-29 remains inferior to the F-15. Although the MIG-29 may carry the newest AA-10 and AA-11 air-to-air missiles, these weapons were not available to the Iraqi air force prior to the conflict. F-15s, flown by American or Saudi Arabian pilots claimed all but two of the coalition's air-to-air kills. Iraqi fighters did not successfully engage a single coalition aircraft. By the year 2000, however, the F-15 may not be so predominant as an air-to-air fighter.

In the year 2000, the average age of the F-15, excluding the F-15E multi-role fighter bomber, will be approximately twenty years old. Airframe ages will vary from twelve to twenty-six.[4] Based on current production numbers, the average age of the newest Soviet fighters, the MIG-29, MIG-31, and the SU-27 will still be less than ten

years old. Although the F-15 will continue to receive upgrades to its avionics and weapons systems, the aging airframe will begin to present a problem. Maintenance man-hours per flight hour will gradually increase. Operational readiness rates will likewise decrease as the years pass. Airframe stress limitations, particularly in available "G" loadings, may be imposed to stretch the useful service life of the aircraft. In addition, yearly aircraft attrition, due mainly to aircraft losses in accidents, will slowly reduce the number of operational F-15s, since they are no longer in production. These aging F-15s may have to compete with an ever increasing fleet of younger Soviet fourth-generation fighters. In addition, these fourth-generation Soviet fighters are closing the technological gap on the F-15. Although their radars and weapons control systems do not yet equal the F-15, they should be essentially equal by the year 2000. Finally, the newest Soviet air-to-air missiles, the AA-10 and the AA-11, are today equal or superior in some respects to the U. S. AIM-7 and AIM-9, respectively.[5] Production and introduction of the Advanced Tactical Fighter was supposed to lessen this growing problem with air-to-air fighters.

Recently flown in an airframe technology fly off, the Advanced Tactical Fighter (ATF) was designed to replace the F-15 as the air superiority fighter of the future. Although the ATF boasts improvements in speed, agility, high

altitude performance, and avionics, the key to its success lies in its stealth technology. The stealth technology planned for the ATF is designed to reduce the effectiveness of the newest Soviet air-to-air and surface-to-air missiles. In essence, the ATF should achieve more kills because it will arrive in a position to fire at its adversary long before the adversary's weapon systems can target the ATF. ATF studies indicate that the ATF engagement survivability would increase 10 percent and its kill ratio would increase 100 percent due to its stealth technology.[6] The ATF has not, however, been funded by Congress. If funded for final development and production in the calendar year 1992, the first operational ATF squadron would not be available until 2002. It is very possible that the ATF will not receive funding in future military budgets and that this important program will be cancelled. The air-to-air combat mission would remain the primary responsibility of the F-15.

The future of the air force's air-to-air capability relies on the integrity of the F-15 and the production and introduction of the ATF. The F-15 will slowly lose its edge over newer Soviet fighters as the years pass. If the ATF is not funded, air-to-air combat capability will predominantly favor newer Soviet fighters within the next ten years.

## Suppression of Enemy Air Defenses

Suppression of enemy air defenses during Operation Desert Storm was the primary responsibility of the F-4G Advanced Wild Weasel. Missions flown from southern bases in Saudi Arabia were flown strictly by F-4Gs. Those missions flown from Incirlik AB, Turkey incorporated F-4G and F-16 "Hunter-Killer" teams. The U. S. Navy provided some defense suppression with the FA-18. All of these aircraft employed SHRIKE and HARM anti-radiation missiles. The difference in these three aircraft was their overall effectiveness.

The F-4G, because of its advanced avionics package designed specifically for the defense suppression mission, had, by far, the best capability to accurately locate, identify, and target specific Iraqi surface-to-air missiles and their associated radars. In order to be effective, those F-16s employed in the defense suppression role were strictly dependent on the F-4G. Without the assistance of the F-4G, F-16s could still employ the HARM missile, but could not discriminate in target selection or location. Capability of the FA-18 exceeds that of the F-16 but falls well short of the F-4G. The F-4G was the true Wild Weasel of Operation Desert Storm. Unfortunately, by the end of calendar year 1992, the last F-4G will be decommissioned from the U. S. Air Force.

Actual decommissioning of the F-4G was delayed because of the onset of Operation Desert Storm. Following the termination of hostilities, the Air Force decided to continue with its decommissioning plan for the F-4G as it "modernized" its forces. Primary responsibility for defense suppression would temporarily fall on the F-16 while the air force developed its follow-on Wild Weasel. Earmarked for this follow-on Wild Weasel mission is the F-15E. The new F-15E is an outstanding replacement airframe for the defense suppression mission. The pilot and weapons systems operator crew of the F-15E is ideal for the defense suppression role. In addition, the F-15E can carry a large quantity and wide variety of weapons, including the SHRIKE and HARM missiles and could easily be modified to carry the advanced avionics required for the Wild Weasel mission. The problem with the F-15E is the number funded for production by Congress.

Initial plans for production of the F-15E included two hundred aircraft. The plan for the F-15E was to replace the F-111 fighter bombers in their deep interdiction role. Decommissioning of the F-111 has begun. Budget constraints have slowly decreased the money available for production of the F-15E. Currently, only seventy-two F-15Es have been purchased by the Air Force. No additional F-15E wings are planned through the year 2000.[7] As aircraft are retrofitted to support the defense suppression role, they will not be available for the deep interdiction mission. During

Operation Desert Storm, approximately seventy F-4Gs flew the bulk of the defense suppression mission. If an equal number of F-15Es are required to fly defense suppression in a future conflict, few will remain for their original purpose, deep interdiction. The Air Force faces a dilemma. Configure F-15Es for the defense suppression role at the expense of deep interdiction, or fly the F-15E in the deep interdiction role and risk the effectiveness of defense suppression to the F-16 and FA-18, when available. In either case, one critical portion of the air supremacy mission, whether it be defense suppression or offensive counter air destruction of aircraft and airfields, will be woefully inadequate.

Current thinking in the Air Force is to use the F-15Es for deep interdiction. Along with the limited number of F-117s, they will provide the bulk of the deep, night, precision counter air missions following the decommissioning of the F-111. F-16s will be responsible for defense suppression. By 1993, defense suppression of surface-to-air missiles systems will be limited, at best.

## Electronic Combat

Electronic Combat in future years should remain rather stable. The four aircraft primarily responsible for this mission will remain the EC-130 Compass Call, EF-111A

Raven, RC-135 Rivet Joint, and the Airborne Warning and Control System (AWACS) modified EC-135. Adjusting the electronic suites in these aircraft should provide adequate modernization for many years to come. The only shortfall in all of these systems is the age of their airframes. By the year 2000, the average age of the EC-130s will be almost thirty years old. EF-111As will average almost twenty-seven years old, and RC-135s and the AWACS will average almost thirty-seven years old.[8] Solutions to this problem may not be all that difficult for planners to solve.

As C-130s are phased out of service, some of the relatively newer airframes could be modified for the Compass Call mission, thereby extending the life of this weapon system. The Air Force could purchase modern, fuel efficient commercial aircraft and convert them for the Rivet Joint and AWACS missions. Regardless, the electronic combat capabilities of these aircraft should remain sufficient to counter any conceivable threat well into the next century.

## Offensive Counter Air Missions

Aircraft flown to destroy enemy airfields, sheltered aircraft, maintenance facilities, command and control facilities and other areas of an enemy's infrastructure, are critical to the air supremacy mission. As the air-to-air fighters, defense suppression fighters, and electronic

combat aircraft destroy or neutralize an enemy's capability to fight back in the air, the offensive counter air fighters finish the destruction of the enemy's air force. In fact, destruction of these assets on the ground is the best way to achieve air supremacy. The role of the other aircraft and their missions is to insure that the offensive counter air fighters can complete their missions with minimal losses.

Four Air Force aircraft, the F-15E, F-16, F-111, and the F-117 provided the bulk of the offensive counter air support for Operation Desert Storm. Three of these aircraft, the F-15E, F-111, and the F-117 flew almost exclusively at night and employed precision guided weapons. Approximately fifty F-15Es supported Operation Desert Storm. The majority of the fifty-seven F-117s on active duty also flew combat missions. F-111s from Europe and the United States completed the compliment of night precision attack aircraft. By the year 2000, the number of night precision attack fighters will have shrunk to approximately two hundred and twenty aircraft as older F-111s are phased out of service.

Assuming 75 percent were committed to a combat area of operations, only one hundred and sixty-five aircraft could provide combat support assuming a 100 percent mission ready rate. These one hundred and sixty-five aircraft could not have supported all the missions flown during Operation Desert Storm. In addition, if F-15Es were allocated to the

defense suppression role, even fewer aircraft would remain available for the offensive counter air support. Capability for night precision attack will almost surely suffer. The future for daytime offensive counter air missions is brighter.

The F-16 provided the bulk of daytime offensive counter air support during Operation Desert Storm. F-16s carried a wide variety of weapons, from the Maverick air-to-surface guided missile to generic MK-82 bombs. F-16 successfully attacked aircraft parked in the open, maintenance facilities, and POL storage areas, as well as dozens of other offensive counter air targets. Future F-16s, carrying the Low Altitude Night Tactical Infra Red Navigation (LANTIRN) and targeting pod will also support the night precision attack role. Again, this will be at the expense of those aircraft assigned to fly the daytime mission. In short, the Air Force's capability to provide offensive counter air support will slowly decrease as older aircraft are decommissioned and are not replaced.

Technology, age, availability, and apportionment of resources are the keys to our ability to project air supremacy in the future. Technologically, Soviet equipment is slowly moving towards parity with modern U. S. equipment. Electronic combat aircraft should continue to provide excellent support to ingressing aircraft. F-15s, although aging, should provide good to excellent air defense against

attacking fighters for the next few years. By the year 2000, however, they will no longer dominate the skies. Newer, abundant Soviet fourth-generation fighters will become predominant unless the Advanced Tactical Fighter is funded and produced. Defense suppression will fall to the F-16 and the FA-18, two aircraft which are capable but inferior to their predecessor, the F-4G. In essence, those weapons systems responsible for clearing the skies in front of attacking offensive counter air fighters will not be capable of providing the support given during Operation Desert Storm.

Without the predominant cover of these support aircraft, the offensive counter air fighters will find it more and more difficult to attack heavily defended targets. In addition, fewer aircraft will remain available for the offensive counter air mission. Consequently, the number of targets attacked will diminish. The net effect will be a resultant loss in U. S. military capability to project air supremacy over enemy territory.

## CHAPTER 7 NOTES

[1] John T. Correll, "New Flags for the Fighting Forces," Air Force Magazine 75, No. 4 (April 1992): 33.

[2] John T. Correll, "Twenty-Six Wings," Air Force Magazine 74, No. 4 (April 1991): 30.

[3] Larry Grossman, "Fighter 2020," Air Force Magazine 74, No.11 (November 1991): 30.

[4] John T. Correll, "The 1991 USAF Almanac: The US Air Force in Facts and Figures," Air Force Magazine 74, No. 5 (May 1991): 52.

[5] Reuben F. Johnson, "Higher Marks for Soviet Missiles," Air Force Magazine 74, No. 8 (August 1991): 60.

[6] Robert R. Blankert, "Advance Tactical Fighter Study: An Annotated Briefing," (Directorate of Aerospace Studies, Kirtland AFB, New Mexico, 1984), 56.

[7] Correll, "Twenty-six Wings," 33.

[8] Correll, "The 1991 USAF Almanac," 52.

# CHAPTER 8

## CONCLUSION

Operation Desert Storm was one of the most successful military campaigns in United States history. The multinational coalition, led by the United States, destroyed the world's fourth largest military in less than two months. The one hundred hour ground campaign which ultimately secured victory for the coalition forces was preceded by an intense air campaign designed to weaken Iraqi air, ground, and naval forces.

Phase One of air campaign was designed to gain air supremacy over Iraqi airspace. Subsequent phases were designed to neutralize Iraqi command and control, destroy their surface-to-surface missile capability, and destroy remaining elements of their military forces. The ground campaign began after these elements were attritted to acceptable levels.

In accordance with Air Force doctrine, Phase One of the air campaign began as the first weapons fell on Iraqi soil. Air-to-air fighters swept the skies of attacking Iraqi interceptors. Defense suppression aircraft neutralized Iraqi surface-to-air missile batteries, allowing

offensive counter air fighters the freedom to attack their targets without significant interference. Finally, deep interdiction missions flown by Stealth fighters and F-15Es destroyed critical command and control facilities, cutting off the Iraqi leadership from their subordinate commanders. These attacks continued twenty-four hours a day. By the fourteenth day of the conflict, the coalition air forces claimed air supremacy over Iraq. From this point until the conclusion of hostilities, air, naval, and ground forces were free to attack targets at the time and place of their choosing without any effective interference from the Iraqi air force.

Consideration of the success of the air campaign produced two key points. The total number of coalition aircraft approximated that of the defending Iraqi air force. The quality of these air forces, however, differed dramatically. The coalition air forces, which consisted primarily of U. S. military aircraft, employed the most modern and sophisticated weapons systems in the world. The Iraqi air force, although significant in depth and versatility, was based upon older, less capable Soviet weapons systems. With few exceptions, the coalition air force completely outclassed their Iraqi counterparts. Ten years from now, this situation could be reversed.

Recent trends in Soviet weapons proliferation indicate that the Soviets are willing to sell their latest

technology to any country possessing enough cash. The poor economic situation in the former Soviet Union could be a major driving force behind this new liberal age of weapons proliferation. In the next ten years, it is conceivable that a country such as Iraq could completely modernize its entire military, including their integrated air defense system. Primary responsibility to destroy this modern integrated air defense system would fall on the U. S. Air Force.

Shrinking military budgets will impose considerable stress on the Air Force. By 1995, the Air Force will maintain only twenty-six operational fighter wings. Mission capability may suffer as each year passes. F-15s, currently the premier air-to-air fighters in the world, will average over twenty years old by the year 2000. The Advance Tactical Fighter, if funded for production, will begin to replace the F-15 in the year 2002. Until this time, the F-15 may have to face a newer, more sophisticated fleet of Soviet fourth-generation fighters. Gone from the Air Force by the end of this year is the F-4G Advanced Wild Weasel. The F-4G provided the primary defense suppression support for Operation Desert Storm. Without this aircraft, the Air Force's capability to effectively suppress enemy surface-to-air missile batteries will be limited at best. Although electronic combat aircraft will still provide good support to ingressing offensive counter air fighters, they

will be subject to attack by an ever increasing number of state-of-the-art weapons. The amount and type of offensive counter air fighters will also continue to shrink. Originally, F-15Es were scheduled to replace the aging F-111s as they were phased out of the Air Force. This phasing out of F-111s has begun. However, further procurement of F-15Es over their current level of seventy-two aircraft is doubtful, primarily because of budget constraints. In essence, fewer aircraft will be available to support the deep interdiction portion of the offensive counter air mission.

The net result is that fewer numbers of aging Air Force fighters and fighter bombers may have to fight a modern adversary, consisting of large numbers of state-of-the-art weapons systems. If this is the case, the U. S. Air Force will be unable to project air supremacy over an adversary's airspace within the next ten years.

## RECOMMENDATIONS

Congress should fund the Advanced Tactical Fighter and accelerate its production and introduction into the active duty Air Force. Congress should fund money for the purchase of additional F-15Es to adequately support the offensive counter air mission. Congress should fund money

to develop a follow-on Wild Weasel defense suppression aircraft. Finally, the United States Air Force should take every step necessary to insure it maintains a capability to project air supremacy over its combat areas of responsibility.

## ACRONYMS

AAA: Antiaircraft Artillery

AI: Air Interdiction

AMRAAM: Advanced Medium Range Air-to-Air Missile

BVR: Beyond Visual Range

ATF: Advanced Tactical Fighter

BAI: Battlefield Air Interdiction

CEP: Circular Error Probable

DCA: Defensive Counter Air

EW: Electronic Warfare

HARM: High-Speed Anti-Radiation Missile

HUD: Heads Up Display

IADS: Integrated Air Defense System

MSIP: Multistage Improvement Program

OCA: Offensive Counter Air

POL: Petroleum, Oil, Lubricants

SAM: Surface-to-Air Missile

SEAD: Suppression of Enemy Air Defenses

TLAM: Tactical Land Attack Missile

## GLOSSARY

ADVANCED TACTICAL FIGHTER (ATF): The next generation air superiority fighter currently in development for the United States Air Force.

AIR INTERDICTION (AI): Aerospace operations designed to delay, disrupt, divert, or destroy an enemy's military potential before it can be brought to bear effectively against friendly forces.

AIRLAND BATTLE: The U.S. Army's basic fighting doctrine which reflects the structure of modern warfare, the dynamics of combat power, and the application of the classic principles of war. AirLand Battle takes an enlarged view of the battlefield, stressing unified air, ground, and sea operations throughout the theater.

AIRLAND OPERATIONS: The Army's umbrella concept for the evolution of AirLand Battle for the strategic Army of the 1990s and beyond.

AIR SUPERIORITY: That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force.

AIR SUPREMACY: That degree of air superiority wherein the opposing air force is incapable of effective interference.

ALL ASPECT FIGHTER: A fighter capable of intercepting and destroying targets in the forward and rear hemispheres and the beam. For the purposes of this paper, aircraft referred to as all aspect fighters will also have look down/shoot down capability, unless noted otherwise.

ANTIAIRCRAFT ARTILLERY (AAA): Artillery whose primary purpose is the destruction of enemy aircraft. Soviet AAA ranges from small arms to 57mm and may be radar or optically guided.

AVIONICS: The electronic equipment in modern aircraft which include navigational, weapons, and countermeasures systems.

BATTLEFIELD AIR INTERDICTION (BAI): Air interdiction attacks against targets which are in a position to have a near term effect on friendly land forces.

BEAM: The area between either the eight o'clock to ten o'clock positions or the two o'clock to four o'clock

positions as viewed by the pilot. Reference to a beam attack applies to an attacking fighter maneuvering to the target's beam for weapons employment. Maneuvering to the beam is a defensive tactic designed to deny or break radar lock by targeting radars.

CHAFF: Small pieces of foil cut in various lengths designed to interfere with search and tracking radar systems. Chaff corridors are "sewn" to hide formations of attacking aircraft from search radars and associated ground control agencies. Aircraft also employ chaff to defeat the terminal phases of missile intercepts or the associated targeting radars.

CIRCULAR ERROR PROBABLE: An area around a target where fifty percent of all weapons would fall. For example, with a circular error probable of ten feet, fifty percent of all bombs (rockets, bullets, missiles, etc) would hit within ten feet of target center.

COUNTER AIR OPERATIONS: Aerospace operations designed to gain control of the aerospace environment.

DEFENSIVE COUNTER AIR (DCA): Aerospace operations conducted to detect identify, intercept, and destroy enemy aerospace forces that are attempting to attack friendly forces or penetrate friendly airspace.

FORWARD HEMISPHERE: Also referred to as the front quarter. The forward hemisphere is the area between approximately the ten o'clock and two o'clock positions as viewed by the pilot.

INTEGRATED AIR DEFENSE SYSTEM (IADS): The combination of aircraft, surface-to-air missile systems, antiaircraft artillery systems, detection systems, and their associated Command and Control designed to intercept and destroy enemy air forces.

NOTCH: The notch is the term used to explain a radars capability to track a target as it maneuvers into the beam. Radars are compared by the width of the notch, usually expressed by relative closure rates in knots. A large notch of +/- 120 knots is considered poor capability whereas a small notch of +/- 30 knots is considered excellent. All attacking fighter aircraft have difficulties with the notch when the target is lower than the fighter. Modern fighters do not generally have a problem with the notch when the target is higher than the fighter.

OFFENSIVE COUNTER AIR (OCA): Aerospace operations conducted to seek out and neutralize or destroy enemy aerospace forces at a time and place of our choosing.

REAR HEMISPHERE: Also referred to as the rear quarter. The rear hemisphere is the area between approximately the four o'clock and eight o'clock positions as viewed by the pilot.

SORTIE: A single mission flown from takeoff to landing. Sortie rate is the number of sorties expected from a single aircraft over a twenty four hour period. Sortie rates are driven by the length of the sortie and the time required to "turn around" the aircraft between sorties.

SUPPRESSION OF ENEMY AIR DEFENSES (SEAD): Aerospace operations which neutralize, destroy, or temporarily degrade enemy air defensive systems in a specific area by physical and/or electronic attack.

SURFACE-TO-AIR MISSILE (SAM): A radar or infrared guided missile and its associated ground support equipment designed to intercept and destroy enemy aircraft.

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